AD-A058 850 HARRIS ECI ASSOCIATES WOODBRIDGE NJ F/G 13/2
NATIONAL DAM SAFETY PROGRAM. MATAWAN LAKE DAM (NJ00086), RARITA--ETC(U)
JUL 78 R GERSHOWITZ DACW61-78-C-0100
UNCLASSIFIED NL

1 OF 2
AD A058850

(1)

RARITAN RIVER BASIN

MATAWAN CREEK, MONMOUTH COUNTY

NEW JERSEY

MATAWAN LAKE DAM

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NJ00086

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE - 2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

JULY 1978

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NJ00086	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Inspection Report National Dam Safety Program Matawan Lake Dam Monmouth County, N.J.		5. TYPE OF REPORT & PERIOD COVERED (9) FINAL rept. 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) Robert Gershowitz P.E.		8. CONTRACT OR GRANT NUMBER(s) (15) DACW61-78-C-0100
9. PERFORMING ORGANIZATION NAME AND ADDRESS Harris-ECI Associates 453 Amboy Ave. Woodbridge, N.J. 07095		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (12) I07p.
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, Philadelphia Custom House, 2d & Chestnut Streets Philadelphia, Pennsylvania 19106		(11) 12. REPORT DATE Jul[redacted]78 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION S(6) National Dam Safety Program. Matawan Lake Dam (NJ00086), Raritan River Basin, Matawan Creek, Monmouth County, New Jersey. Phase 1 Inspection Program.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams--New Jersey
National Dam Safety Program Phase I
Dam Safety
Matawan Lake Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

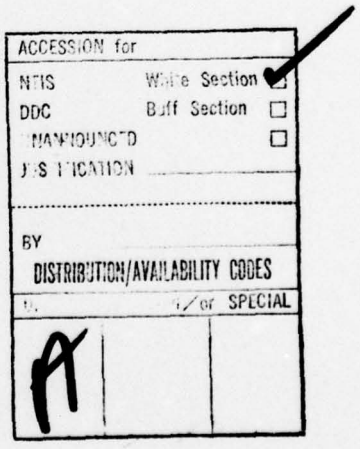
DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

410 824

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

NOTICE

THIS DOCUMENT HAS BEEN REPRODUCED FROM THE BEST COPY FURNISHED US BY THE SPONSORING AGENCY. ALTHOUGH IT IS RECOGNIZED THAT CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED IN THE INTEREST OF MAKING AVAILABLE AS MUCH INFORMATION AS POSSIBLE.



DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

30 AUG 1978

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Matawan Lake Dam in Monmouth County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given on the first three pages of the report.

Based on visual inspection, available records, calculations and past operational performance, Matawan Lake Dam is judged to be in poor overall condition. The spillway is considered to be marginally adequate. To insure adequacy of the structure the following actions, as a minimum, are recommended:

a. The owner shall engage a qualified professional consultant to determine the actual capacity of the spillway using more precise and sophisticated methods and procedures. The hydraulic and hydrologic study should be completed within twelve months from the date of approval of this report. In the event the further spillway capacity study indicates the need for increased hydraulic capacity, such remedial work should be initiated in calendar year 1979.

b. Within nine months from the date of approval of this report engineering investigations and studies should be made to more accurately determine the dams stability. Studies should include phreatic levels, soil properties, spillway slab uplift, pile foundation data and other information necessary to determine the need for remedial actions. Any such remedial actions should be initiated in calendar year 1979.

c. The following remedial actions should be completed within the below listed times from the date of approval of this report:

(1) Restore operating capability of low level outlet within three months and transfer its operation point to a safe location within six months.

(2) Establish a warning system within three months.

(3) Install and begin logging a lake level gage within three months. Also, establish a more price rating curve for the spillway and low level outlet.

(4) Establish and execute a comprehensive operation and maintenance procedure for the dam within six months. Maintenance shall include control of embankment vegetation.

d. The Hazard Classification of this dam has been changed from "high" to "significant."

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James J. Howard of the Third District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, thirty days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia, 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely yours,

James G. Ton

1 Incl
As stated

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

Cy furn:
Mr. Dirk C. Hofman, P.E.
Department of Environmental Protection

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

Based on visual inspection, available records, calculations and past operational performance, Matawan Lake Dam is judged to be in poor overall condition. The spillway is considered to be marginally adequate. To insure adequacy of the structure the following actions, as a minimum, are recommended:

a. The owner shall engage a qualified professional consultant to determine the actual capacity of the spillway using more precise and sophisticated methods and procedures. The hydraulic and hydrologic study should be completed within twelve months from the date of approval of this report. In the event the further spillway capacity study indicates the need for increased hydraulic capacity, such remedial work should be initiated in calendar year 1979.

b. Within nine months from the date of approval of this report engineering investigations and studies should be made to more accurately determine the dams stability. Studies should include phreatic levels, soil properties, spillway slab uplift, pile foundation data and other information necessary to determine the need for remedial actions. Any such remedial actions should be initiated in calendar year 1979.

c. The following remedial actions should be completed within the below listed times from the date of approval of this report:

(1) Restore operating capability of low level outlet within three months and transfer its operation point to a safe location within six months.

(2) Establish a warning system within three months.

(3) Install and begin logging a lake level gage within three months. Also, establish a more price rating curve for the spillway and low level outlet.

(4) Establish and execute a comprehensive operation and maintenance procedure for the dam within six months. Maintenance shall include control of embankment vegetation.

d. The Hazard Classification of this dam has been changed from "high" to "significant."

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 30 Aug 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Matawan Lake Dam, I.D. NJ 00086
State Located:	New Jersey
County Located:	Monmouth
Stream:	Gravelly Brook
Date of Inspection:	May 8 and 10, 1978

Assessment of General Condition of Dam with respect to Safety and Recommended Action with Degree of Urgency

- The Spillway Design Flood (SDF) for Matawan Lake Dam is in the range between the 100-year flood and one half of the Probable Maximum Flood (PMF). The spillway is barely adequate to pass the 100-year flood without overtopping and can safely pass only 18 percent of the one half PMF. Overtopping carries with it the serious risk of washing out the dam. The PMF was determined by Standard Corps of Engineers screening procedures and should be verified by the owner by more accurate or sophisticated methodologies and procedures.

  An investigation to increase the capacity of the spillway should be completed within 15 months, presenting an approved plan.

- Additional investigations to acquire needed engineering data relating to the assessment of stability and safety of the embankment and spillway are required as listed below:

  1. Determination of phreatic surfaces in the left embankment and uplift pressure under the spillway apron slab.

2. Determination of engineering properties of the soils in the embankment and of the underlying soils in the subgrade.

3. Acquisition of sufficient as-built data to produce a coherent set of engineering drawings showing embankment cross sections and pile foundation data at the rebuilt bridge abutments.

The additional information should be acquired within a period of 9 months.

- Additional embankment and spillway stability investigations are required. The ability of the present pile support under the spillway to resist lateral hydraulic loadings at current and PMF lake levels is questionable. The stability of the left embankment is also questionable since it exhibits seepage, has its toe ending in the channel of Gravelly Brook, and has a downstream slope considered excessively steep. The top part of the embankment is supported by a timber retaining wall in deteriorated condition.

  These investigations should be completed and corrective plan formulated within 15 months.

- The low level outlet is currently inoperable. It should be restored to operation within 3 months. The operation of the gate is dangerous at high lake levels and the operation point should be transferred from the spillway crest to a dry land location on the Main Street sidewalk within 6 months.

- Operation and Maintenance Procedures - An annual inspection is recommended utilizing a visual check list similar to that used in this investigation.

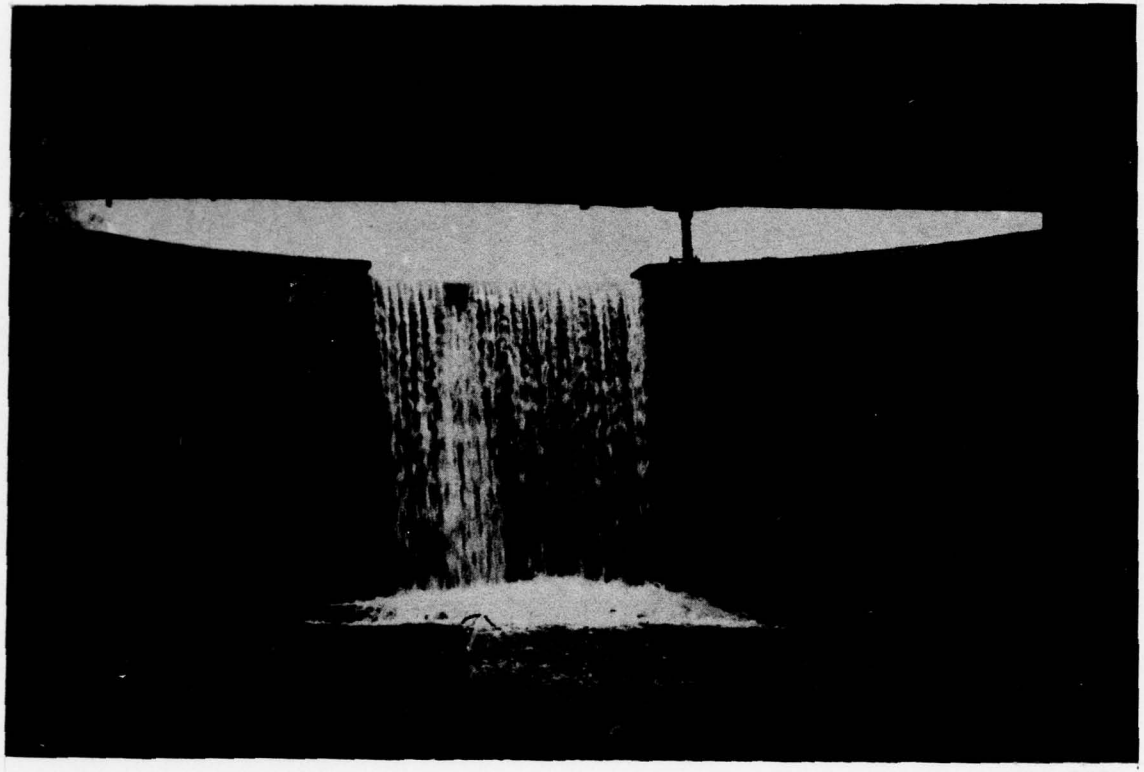
- A warning system should be established between the Monmouth County dam operators and the Borough of Matawan Police to bar traffic from Aberdeen Road during periods of high inflows and impending embankment overtoppings.

- A lake level gage should be affixed to the upstream side of the roadway bridge and read at routine maintenance visits and at times of high water. A more precise rating curve for spillway and the low level outlet discharges should be established.

- The Hazard Potential of this dam has been changed from "High" to "Significant" on the basis of this investigation.

Robert Gershowitz, P.E.

Robert Gershowitz, P.E.



May 1978

MATAWAN LAKE DAM

TABLE OF CONTENTS

ASSESSMENT OF GENERAL CONDITION OF DAM WITH RESPECT TO SAFETY AND RECOMMENDED ACTION WITH DEGREE OF URGENCY

TABLE OF CONTENTS
(Continued)

PLATES

APPENDICES

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

MATAWAN LAKE DAM, I.D. NJ 00088

SECTION 1

1. PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August 1972 authorizes the Secretary of the Army, through the Corps of Engineers to initiate a program of safety inspections. The inspection of Matawan Lake Dam was carried out under Contract DACW61-78-C-0100 to the Department of the Army, Philadelphia District, Corps of Engineers by the engineering firm of Harris-ECI Associates of Woodbridge, New Jersey.

b. Purpose of Inspection

The purpose of the inspection and evaluation is to identify conditions which threaten the public safety and thus permit the correction of the conditions in a timely manner by the owners. The National Inventory of Dams will be updated by the data acquired during the inspection.

1.2 Description of Project

a. Description of Dam and Appurtenances

Matawan Lake Dam consists of a concrete spillway of circular segment shape in plan which has been added upstream of an existing masonry and concrete bridge spanning over Gravelly Brook. A roadway embankment ties into both bridge abutments and connects the bridge to higher ground on

both sides. The embankment top carries Main Street, a two-lane bituminous paved road across the brook. Upstream cutoff under the spillway is accomplished by a single row of 4-inch thick tongue and groove timber sheet piles, 18-foot long extending down to elevation -10.7, and connected to the existing upstream bridge abutment walls by means of a 12-inch thick reinforced concrete cutoff wall. (Drawing 2). The timber sheet piling is continued along the upstream face of the embankment at various bottom elevations and terminating on the top at elevation 19.3 which is one foot above the lake level. The total extent of the timber sheet piling along the right embankment is approximately 125 feet from the centerline of the stream and approximately 150 ft. from the centerline of the bridge along the left embankment section.

The spillway bridge spanning across Gravelly Brook is of masonry and reinforced concrete construction having apparently been reconstructed in 1925, in connection with the spillway addition. The downstream bridge wingwalls were also added in 1925, and are of reinforced concrete supported on timber piles, replacing earlier ones of masonry construction. No data is available for the earlier masonry bridge abutments and foundations which were partially reused in the 1925 reconstruction. The bridge superstructure consists of concrete encased steel stringers and dates from 1925.

The downstream right embankment slope is approximately 1 vertical on 2 horizontal, is poorly dressed and overgrown with vegetation in the wild state. The downstream left embankment slope is apparently steeper than 1 on 2 horizontal, and the roadway fill for the top 6 to 8 feet of the embankment is retained by timber sheeting and vertical timber piles. The timber piles at the supported face are further stabilized by a second row of downstream kicker or anchor piles which are connected to the primary row by substantial timber braces. This system extends along the embankment for about 60 feet from the face of the bridge abutment. Further out, the second row of kicker piles is discontinued and the primary row of piles are tied back into the embankment. The roadway

embankment slopes steeply away from the low timber retaining wall at the top. The toe of the embankment ends at the channel bank of Gravelly Brook which turns left upon passing through the bridge opening and then runs parallel to all of the left embankment toe.

The left embankment is extremely irregular, locally eroded and covered with brush in the wild state.

A 30-inch dia. low level outlet has been provided through the spillway, controlled by a faced mounted gate valve on the upstream side.

The reservoir rim is relatively steep and is covered by second growth timber.

The downstream channel of Gravelly Brook meanders in low banks in a wide tidal plain, joining the channel and tidal flat area of Matawan Creek within 200 yards downstream of the dam.

b. Location

Matawan Lake Dam is located on Gravelly Brook in the Borough of Matawan. The roadway embankment carries Main Street across the brook. Gravelly Brook is a tributary of Matawan Creek which forms its own small local drainage basin flowing into the Raritan Bay part of the Atlantic Ocean. The downstream area is part of the Borough of Matawan.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection" by the U.S. Department of the Army, Office of the Chief of Enginers, the dam is classified in the dam size category as being "Small", since its storage is less than 1,000 acre-feet. The dam is also classified as "Small" because its height is less than 40 feet. The overall size classification is "Small".

d. Hazard Classification

The dam has been listed in the National Inventory of Dams as having High Hazard Potential, on the basis that in the event of failure of the dam and its appurtenances, excessive damage could occur to downstream property together with the possibility of the loss of more than a few lives. Visual inspection shows that the downstream tidal flat into which the dam discharges is very wide. The adjacent residences are all on higher ground approximately even with the dam crest level and would not be subject to inundation in case of dam failure. Downstream, a high railroad embankment pierced by three 10-foot diameter culverts could control tailwater levels in the reach between it and the dam, and could control downstream discharges of both Gravelly Brook and Matawan Creek at PMF levels. Matawan Lake has a low storage volume and the impounded depth is also low. The only possible downstream danger area is the undeveloped stretch of Aberdeen Road crossing the tidal flat of Matawan Creek just upstream of the railroad. At PMF levels, this road could become dangerous to travellers.

On the basis of the above facts, it is recommended that the Hazard Potential of Matawan Lake Dam be revised from "High" to "Significant".

e. Ownership

Matawan Lake Dam is owned by the Borough of Matawan. Operational control and maintenance is provided by Monmouth County.

f. Purpose of Dam

The dam serves as a Borough recreation facility for small non-powered boating and fishing.

g. Design and Construction History

No data was recovered in the files of the New Jersey Department of Environmental Protection (NJ-DEP) relating to the dam construction and design. Available drawings dated 1923 show that the spillway was added

to a reconstructed bridge and roadway embankment. The actual work was completed in 1925. Addition of a sheet pile headwater cutoff for the embankment was part of the 1925 reconstruction. The downstream timber retaining wall at the very top of the embankment dates to 1928, according to plans furnished by the Monmouth County.

No inspection reports relating to the construction are in the files of the NJ-DEP.

h. Normal Operating Procedures

The normal operating procedure is to allow the stream water to flow over the spillway, keeping the low level outlet closed. The low level outlet could be of value during rainstorms if it were operational. The low level outlet could also be used to draw-down the water level in the reservoir for reservoir dredging purposes, if so required.

1.3 Pertinent Data

a. Drainage Areas

At dam axis, drainage area is 2.7 square miles.

b. Discharge at Dam Site

Maximum known flood at dam site:	Unknown, estimated at less than 1,000 cfs on the basis that the dam has not been overtopped, according to available information
Warm water outlet at pool elevation:	NA
Diversion tunnel low pool outlet at pool elevation:	NA
Diversion tunnel outlet at pool elevation:	NA
Gated spillway capacity at pool elevation:	NA

Gated spillway capacity at maximum pool elevation:	NA
Ungated spillway capacity at maximum pool elevation:	270 cfs (Elev. 19.77)
Total spillway capacity at maximum pool elevation:	270 cfs (Elev. 19.77)

c. Elevation (feet above MSL)

Top dam:	21.27
Maximum pool, design surcharge:	19.77
Full pool control pool:	NA
Recreation pool:	18.27
Spillway crest:	18.27
Upstream portal invert diversion tunnel:	NA
Downstream portal invert diversion tunnel:	NA
Streambed at centerline of dam:	Estimated at Elev. 1.8
Maximum tailwater:	Tidal area, Mean high tide Elev. 3.1 Stage discharge relationship not available

d. Reservoir

Length of maximum pool:	4,300 feet
Length of recreation pool:	2,800 feet
Length of flood control pool:	NA

e. Storage (acre-feet)

Recreation pool:	280 (Elev. 18.27)
Flood control pool:	NA
Design surcharge:	326 (Elev. 19.77)
Top of dam:	379 (Elev. 21.27)

f. Reservoir Surface (acres)

Top dam:	38 A (Elev. 21.27)
Maximum pool:	33 A (Elev. 19.27)
Flood-control pool:	NA
Recreation pool:	28 A (Elev. 18.27)
Spillway crest:	28 A (Elev. 18.27)

g. Dam

Type:	Earth embankment with circular segment concrete spillway
Length:	275
Height:	19.5 feet
Top width:	Approx. 48 feet
Side slopes - Upstream:	Unknown, listed as vertical in NJ-DEP files
-Downstream:	1V on 2H on right embankment steeper than 1V on 2H on left embankment
Zoning:	Unknown
Impervious core:	Unknown
Cutoff:	4-inch timber T&G sheet piles
Grout curtain:	None

h. Diversion and Regulating Tunnel

Type:	NA
Length:	NA
Closure:	NA
Access:	NA
Regulating facilities:	NA

i. Spillway

Type:	Circular concrete wall
Length of weir:	57 feet
Crest elevation:	Notch 12-foot long at Elev. 18.27; remainder at Elev. 18.77
Gates:	None
U/S Channel:	None
D/S Channel:	Under spillway bridge, 42-foot wide with paved invert; natural channel beyond bridge

j. Regulating Outlets

Low level outlet:	One, 36-inch diameter
Controls:	Gate valve on upstream face. Operated only from top of spillway crest
Emergency gate:	None
Outlet:	Into paved area below bridge

SECTION 2

2. ENGINEERING DATA

2.1 Design

Drawings in the files of the New Jersey Department of Environmental Protection (NJ-DEP) and Monmouth County relate to the reconstruction of the existing bridge, and the embankment cutoff at the time the concrete spillway was added. No drawings relating to the embankment, useful for assessing stability, have been recovered; nor is any drawing available concerning the foundation of the reconstructed bridge. No data is available concerning the foundation materials under the dam or the materials in the roadway embankment.

2.2 Construction

No construction reports are available from the NJ-DEP files dating back to the time the embankment and bridge were modified to serve as a water impounding facility.

In 1925, the existing bridge and embankment were modified as follows:

1. The circular spillway was added to the upstream side of the spillway, supported on timber piles. The existing upstream abutment masonry walls were faced with a 12-inch thick reinforced concrete wall to serve as a connection to the spillway and as part of the headwater cutoff. The concrete cutoff wall was continued 25 feet to the left of the end of the bridge abutment wall as a further cutoff and core wall provision.

2. A 4-inch timber sheet piling cutoff was provided along the embankment, under the reinforced concrete cutoff wall and under the spillway.

3. The bridge superstructure was replaced, utilizing part of the existing stone masonry abutments.

4. A new pair of reinforced downstream concrete wingwalls were added, replacing the existing masonry walls. The new wingwalls were supported on timber piles.

5. The invert of the bridge waterway was paved with a 8-inch thick reinforced concrete slab supported on a timber form deck and timber piles.

In 1928, the emabnkment was modified by supporting the upper 6 to 8 feet on the downstream side by timber sheeting and timber piles.

2.3 Operation

No data is available on the operation of the dam, except for verbal evidence form the Monmouth County engineer that the existing dam has not been overtopped in the last two decades.

2.4 Evaluation

a. Availability

The availability of data is not sufficient to assess the safety of the structure. Needed for proper assessment are:

1. A coherent set of as-built drawings incorporating existing data and adding additional information by survey as needed. Data concerning the slopes of the upstream and downstream embankment, the adjacent lake bottom and the downstream channel is especially needed.

2. Data relating to the engineering properties of the embankment materials and the underlying foundation soils.

3. Data relating to the phreatic levels within the embankment.

4. Data relating to the support of the pre-existing abutments of the rebuilt bridge.

b. Adequacy

The existing engineering data is insufficient for a definitive safety evaluation. It is recommneded that the data in Section 2.4 - a. be acquired within 9 months.

c. Validity

The existing information uncovered appears to be valid based on visual inspection of the dam with the following exception:

The anchor pile system for the support of the downstream roadway retaining wall has been identified only for the first five anchor piles, compared to the drawings which indicate anchorage for the full length of the wall.

SECTION 3

3. VISUAL INSPECTION

3.1 Findings

a. General

Matawan Lake Dam is in poor overall condition physically. This is primarily related to the condition of the downstream roadway embankment which is overly steep; has its toe ending in the downstream brook channel; and is poorly supported at the top.

b. Dam

- Embankment

The earth dam right bank is locally eroded and at places overgrown with shrubs and trees. No leaks could be observed. The left abutment slope is overly steep, very irregularly eroded, and covered with wild brush. The toe of the embankment ends in the downstream channel of Gravelly Brook. The top 6 to 8 feet of the embankment is supported by timber sheeting and timber piles in deteriorated condition. The primary timber piles are additionally supported by tie back rods or by a second row of timber anchor or "kicker"piles driven downstream of the primary row and connected to it by sloping timber struts. The tie back rods have pulled through the deteriorated wood of several piles and these piles have apparently moved forward approximately 12 inches. The downstream lane of the road appears excessively crowned because of the retaining wall movements and the associated embankment settlements under the lane.

The left abutment exhibits some slight clear water seepage at a point approximately 100 feet to the left of the bridge abutment and continuing to the left abutment contact, at an elevation approximately 10 feet below the roadway level. There is also some seepage adjacent to the base of one of the timber retaining wall piles, also of slight volume.

- Spillway

The visible concrete surfaces of the spillway are in fair and acceptable condition with some roughening of the surfaces due to erosion. The spillway crest is smooth and apparently level. The construction joints are tight but show surface cracking. There is some local spalling and deterioration in the formed hole for the 36-inch diameter low level outlet.

- Spillway Bridge

The masonry abutments are in generally fair to poor condition, with the left abutment showing diagonal settlement cracks. The left downstream wingwall has a large through-wall crack near the top. The superstructure is in acceptable condition.

- Low Level Outlet

The spillway structure contains one 36-inch diameter outlet, controlled by a sluice gate mounted on the upstream face of the spillway. The sluice gate is of the standard pressure seating type operated by a handwheel acting directly on a rising stem.

At the point where the stem passes through the water surface, corrosion has reduced the diameter to approximately 35 percent of the original diameter. This means that only 12 percent of the original cross sectional area of the stem remain. At the time of the inspection, the hand wheel was frozen and could not be moved. In general, the valve stand showed no signs of maintenance. There was no evidence of grease, and the stem threads were quite dry.

In its present condition, this sluice gate is considered inoperable and the reservoir, therefore, has no facilities for emergency drawdown.

- Reservoir

The reservoir rim upstream of the dam is fairly steep right down to the water level. No shoreline protection could be noted. The reservoir has silted considerably and approximately 20 to 25 percent of the original lake surface has silted in at the upstream end of lake. At present, siltation extends from Church Street in its former end to New York Central Trestle.

- Geology

The dam is founded on glauconitic sands interbedded with thin beds of clayey silt (Merchantville formation). This formation also rims most of the reservoir. A dark gray clay (Woodbury clay) crops out along the eastern edge of the reservoir and rims the remaining reservoir outline.

- Downstream Channel

The downstream channel of Gravelly Brook turns 90 degrees after passing through the embankment and runs parallel to the toe of slope of the left abutment embankment and then forms the remainder of a half loop to the left. The banks, although shallow are well defined within a wide tidal flat. The tidal flat of Gravelly Brook joins the wider tidal flat of Matawan Creek, some 200 yards downstream. There are no residences downstream in low lying areas. The existing buildings are built on the higher ground of the banks defining the wider tidal flat. The only low lying facility is Aberdeen Road which crosses the tidal flat of Matawan Creek some 1,000 feet downstream of the dam axis. This road is not developed, but could be dangerous in case of dam failure, dam overtopping, or flood flows of PMP magnitude. Aberdeen Road is just upstream of a high railroad embankment belonging to the New York and Long Branch Railroad. The embankment is pierced by 3-10-ft. diameter culverts which could control the tailwater of Matawan Creek and Gravelly Brook at PMP levels, at the same time protecting the downstream part of Matawan Borough in case of PMP level floods.

3.2 Evaluation

1. Embankment

The left embankment section is in an unacceptable poor condition. It shows leakage, the downstream slope is steep, and the low timber retaining wall at the top has deflected and the wood is deteriorated. The toe of the slope runs directly into the Gravelly Brook, whose channel loops undesirably in front of the embankment. The slope is highly irregular locally eroded and covered with brush and small trees.

2. Spillway Bridge

The left abutment shows settlement cracks in the reutilized masonry portion which should be further studied to assess the significance with respect to dam safety.

3. Low Level Outlet

The low level outlet is inoperable. The gate operating stem is corroded to a small fraction of its nominal area and the operating wheel is frozen and inoperable. The hand wheel is directly mounted on the spillway crest and would be dangerous to operate if needed during a period of heavy overflow over the spillway. The inoperability of this outlet is unacceptable to the overall safety of the dam.

SECTION 4

4. OPERATIONAL PROCEDURES

4.1 Procedures

The lake surface is unregulated, with water levels passing over the two-level spillway crest at a depth required to convey reservoir inflow. The low level outlet is inoperable and is not used to augment spillway capacity.

4.2 Maintenance of Dam

The dam is maintained by Monmouth County on an as-needed basis. Based on visual evidence, no significant maintenance has been provided in the last half century.

4.3 Maintenance of Operating Facilities

The maintenance of the low level outlet gate has been neglected, with the result that this gate is now inoperable.

4.4 Description of any Warning System in Effect

There is no warning system in effect which would alert Borough officials in case of impending overtopping of the dam, any threatened malfunction, or expected high reservoir outflows.

4.5 Evaluation

The maintenance of this dam has fallen below acceptable levels. It is recommended that an annual visual inspection be carried out utilizing a format similar to the one appended as part of this inspection report. Operating rules for regulating the lake level at PMP levels should be drawn up and tie line to Borough Police should be established to close off Aberdeen Road at impending dam overtoppings.

SECTION 5

5. HYDRAULIC / HYDROLOGIC

5.1 Evaluation of Features

a. Design

Matawan Lake impounds water drained by Gravelly Brook which drains south to north from Beacon Hills to Matawan Lake. Matawan Lake Dam is located on the northeast side of the Borough of Matawan. Gravelly Brook drains an area of approximately 2.7 square miles. A drainage map of the watershed of Gravelly Brook and the dam site is presented on Plate 1, Appendix D.

The topography within the basin varies from foothills type terrain in the northern section, to generally hilly in the southern section. Elevations range from approximately 17 feet above mean sea level at the dam site to over 300 feet above mean sea level in the Beacon Hills at the south end of the watershed.

Land use pattern within the Gravelly Brook watershed is mostly urban with some forested lands in the hilly southern section of the basin. Most of the urban areas are located along the rim of Matawan Lake. Very little lands within the basin are devoted to agricultural use.

The evaluation of the hydraulic and hydrologic features of Matawan Lake Dam was based on criteria set forth in the Corps Guidelines and additional guidance provided by the Philadelphia District, Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation using Hydrometeorological Report No. 33 with standard reduction factors. Due to the small drainage area of Matawan Lake, the SCS triangular hydrograph transformed to a curvilinear hydrograph was adopted for developing the unit hydrograph. The derived unit hydrograph is presented under the section of hydrologic computations.

Initial and infiltration loss rates were applied using SCS procedure to the Probable Maximum Storm rainfall to obtain rainfall excess. The rainfall excess was then applied to the unit hydrograph to obtain the PMF hydrograph utilizing the computer program HEC-1.

The computed peak discharge of PMF and one half of the PMF are 11,695 cfs and 5,847 cfs respectively.

The 100-year design discharge for Gravelly Brook at the dam has been computed by the N.J. Department of Environmental Protection and is given as 1,060 cfs. Both the PMF and one half of the PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method, also utilizing computer program HEC-1. The peak outflow discharges for the PMF and one half of PMF results in overtopping of the dam, but the 100-year flood flow can be passed with lake level just at the top of dam.

The stage-outflow relation for the spillway was prepared from field notes, sketches and available construction drawings. The reservoir stage capacity data were based on U.S.G.S. quadrangle maps in combination with data given in the National Dam Safety Inventory. Reservoir storage capacity included for surcharge levels exceeding the top of the dam and the spillway rating curve assumed that the dam remains intact during routing. In the routing computations, the discharge through outlet facilities was excluded due to its insignificant magnitude as compared to the spillway discharge and the PMF. The spillway rating curve and the reservoir capacity curve are presented in Plates 2 and 3 of Appendix D respectively.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site. However, according to interviews with local residents, the maximum reservoir level was never higher than the Main Street surface.

c. Visual Observations

Silting has occurred to a visible degree at the upstream end of the reservoir, but it does not affect the validity of the reservoir routing which assumes the reservoir at spillway crest level at the start of the PMP. Silting will affect any routing procedure that uses lake storage below the spillway crest level.

d. Overtopping Potential

As indicated in Section 5.1.a., one half of the PMF, when routed through Matawan Lake results in overtopping the dam. One half PMF overtopped the dam by 2.4 feet.

The spillway is capable of passing the 100-year flood, but is only capable of passing a flood equal to approximately 9.5 percent of the PMF without overtopping the dam (19 percent of one half PMF). Since the Spillway Design Flood (SDF) for this dam is in the range of the 100-year flood to one half of the PMF, according to the Recommended Guidelines for Inspection of Dam by the Corps, the spillway capacity of the Matawan Lake Dam is considered marginally adequate.

e. Reservoir Drawdown

Assuming the 36-inch diameter low level outlet is made operational, the reservoir drawdown below the spillway crest elevation can be accomplished by permitting discharge through the 36-inch outlet pipe with invert elevation 3.02. Assuming drawdown to the top of the pipe, and a constant inflow of 5.4 cfs (2 cfs/acre), the drawdown can be accomplished in one day and 22 hours. Assuming no inflow into the reservoir, the drawdown time is reduced to one day and 16 hours.

SECTION 6

6. STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

Visual observations casting doubt as to the stability of the spillway and bridge structure center on the settlement cracks noticed on the left bridge abutment. These cracks are in the cut-stone masonry of the original bridge structure existing at the site that was modified in 1925 to form the present abutments. It cannot be determined whether the crack was preexisting, was caused by differential vertical loadings or foundation settlements, or was caused by horizontal water thrust delivered to the abutment by the horizontally arched spillway.

The excessively irregular and locally eroded surface of the left down stream embankment is a visual sign of slope instability. Leakage emanating on the downstream face of the slope is an indication of inadequate embankment cutoff or a lack of proper embankment zoning.

The deflected piles retaining the top part of the left downstream embankment could have been moved by excessive lateral pressures on the sheeting. An alternate explanation is that the timber has deteriorated to a point where the design load on the tie back rods has exceeded the cross fiber shearing strength of the piles, causing the pull through failure observed.

b. Design and Construction Data

There is insufficient data available on the existing structure to assess its structural stability. Pile plans are available for the spillway structure (not included in plates because of poor reproduction quality) but these piles are insufficient to fully resist the lateral thrust from the spillway. The pile plans for the original part of the rebuilt

bridge abutment are not available. The downstream wingwalls have an inordinately high concentration of piles supporting them and the conclusion reached is that these piles were meant to aid in resisting the horizontal hydraulic thrust of the spillway being transmitted through the rebuilt bridge abutments. Even counting all the vertical piles under the spillway, the spillway apron, the invert paving under the bridge and the downstream wingwalls, there is insufficient lateral pile resistance available to resist lateral loads on the spillway without relying on either the unknown pile capacity of the foundation system under the original bridge abutment or on the passive resistance of the embankment itself. No computations relating to the stability of the spillway or the embankment have been uncovered.

Insufficient data is available to assess the stability of the deflected retaining wall system. Insufficient data relating to the engineering properties of the embankment and foundation materials, and the cross sectional configuration of the embankment is available to properly assess its stability.

c. Operating Records

There are no operating records available relating to the stability of the dam. As mentioned above, the dam has apparently never been overtopped.

d. Post Construction Changes

The dam, as presently standing, dates back to the construction completed in 1925 and 1928, as detailed above. There have been no post construction changes affecting the stability of the dam.

e. Seismic Stability

In general, projects located in Seismic Zone 0, 1 and 2 may be assumed to present no hazard from earthquake, provided that static stability conditions are satisfactory and conventional safety margins exist.

SECTION 7

7. ASSESSMENT / REMEDIAL MEASURES

7.1 Dam Assessment

The dam has been inspected visually and a review has been made of the available engineering data. This assessment is subject to the limitations inherent in the visual inspection procedures stipulated by the Corps of Engineers for Phase I Report.

On the basis of this inspection, the Hazard Potential of Matawan Lake Dam has been changed from "High" to "Significant".

a. Safety

The safety of Matawan Lake Dam is questionable due to the following:

1. The spillway capacity is marginally adequate, incapable of passing one half of the PMF, but able to pass the 100-year flood with a water level just at the top of the dam.

2. The downstream slope of the left embankment is excessively eroded and steep, and the toe ends in the channel of Gravelly Brook. The embankment leaks, and the timber wall retaining the upper embankment has deteriorated.

3. The nominal lateral pile resistance of the spillway and bridge abutments is believed to be insufficient to independently resist the lateral hydraulic thrust of water impounded behind the spillway.

4. The low level outlet is inoperable in its present state, and cannot be conveniently operated from a safe access position during high lake stages. Unavailability of low level outlet capacity increases the danger of dam overtopping during floods of intermediate frequency. This outlet should be made operable.

b. Adequacy of Information

- The hydrologic information is adequate for the present investigation and is based on Corps of Engineers screening procedures. The owner should verify the adequacy of the existing spillway capacity by more accurate or sophisticated methodologies.

- Data relating to the capacity of the spillway and bridge foundation to resist the hydraulic thrust on the spillway is inadequate to assess its stability. Needed information includes:

  1. Determination of pile configuration under the rebuilt masonry bridge abutments.

  2. Determination of engineering properties of the soil under the spillway and bridge.

  3. Acquisition of information on uplift pressures under the spillway apron slab.

- Data relating to the stability of the left abutment embankment is inadequate to assess its stability. Needed information includes:

  1. Acquisition of cross sectional data of the roadway embankment including the geometry of the upstream slope.

  2. Determination of engineering properties of the embankment fill and of the foundation subgrade below it.

  3. Location of phreatic levels within the embankment at various points upstream and downstream of the roadway.

c. Urgency

- The low level outlet should be restored to full operational capability within 3 months. The position of operation should be changed over to a safer location along the sidewalk area of the bridge within 6 months. An extension crank for the gate operating stand is a possible method of achieving safer operation.

- The engineering data required to assess the stability and safety of the spillway and embankment should be acquired within 9 months and the stability reassessed within 12 months.

- A plan for improving the stability of the embankment and spillway should be formulated and approved within 15 months.

- A plan for increasing the capacity of the spillway should be formulated and approved within 15 months.

d. Necessity for Further Investigations

Based on the analyses of the dam safety presented above, further investigations are required.

7.2 Remedial Measures

a. Alternatives

- The stability of the embankment can be improved as follows:

1. Regrading the downstream slope, and adding slope protection or stabilizing vegetative cover.

2. Rebuilding the timber retaining wall at the top of the embankment, replacing all deteriorated timber piles, walers and sheeting as required.

3. Flattening the entire downstream slope by eliminating or abandoning the top retaining wall, and continuing the slope down to the tidal flat level. The toe of the slope would be protected by heavy stone riprap, and the downstream channel of Gravelly Brook would be shifted away from the toe of slope to accommodate the flattened slope.

4. Addition of another row of sheet piling in order to lower the phreatic level within the embankment should piezometric gage data indicate this to be desirable.

5. An appropriate combination of the above alternatives.

- The possible alternatives for improving the spillway capacity are as follows:

  1. Addition of an auxiliary spillway with large gates or stop log plank sections that could be removed before or during an anticipated large storm event.

  2. Hardening of the embankment or abutments to allow limited, non-damaging overflows to pass over.

  3. Lowering of the existing permanent spillway crest level, and rebuilding the top to accommodate flashboards or stop plank grooves.

  4. Providing additional low level outlet capacity to permit lowering the lake level in anticipation of expected heavy rainstorm events.

- Possible alternatives for improving the lateral load resistance capacity of the spillway are:

  1. Addition of batter piles on the downstream side of bridge abutments and connecting them to the abutment.

  2. Consideration of part of the embankment together with the spillway and bridge section to calculate a combined adequate factor of safety. An effective tie between the two parts would have to be designed.

b. O & M Procedures

The recommended procedures for operation and maintenance of Matawan Lake Dam are as follows:

1. Setting up of operating rules for regulating the lake level during periods of high inflow.

2. Setting up of maintenance schedules for the maintenance of the low level outlet gate and the control of vegetation on the embankment. Maintenance of a permanent log of operational and maintenance visits to the dam, including the low level outlet operation.

3. Initiation of an annual visual inspection of the dam utilizing a check list similar to the one used in this report.

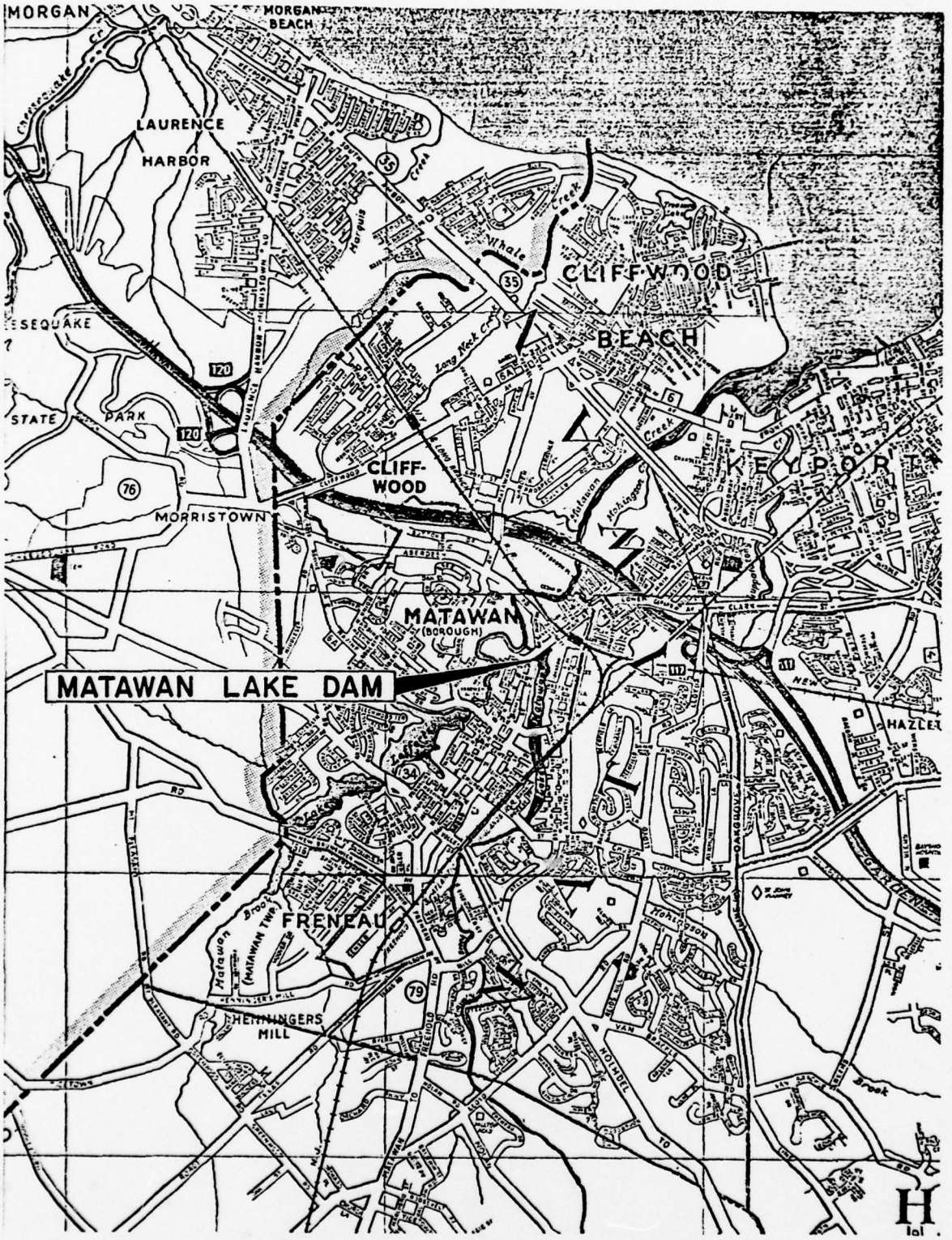
4. Establishment of communication channels to the Matawan Police to bar traffic from Aberdeen Road during periods of heavy inflow into Lake Matawan or impending overtopping of the dam.

5. Addition of a reservoir level gage at the upstream face of the abutment which would be read at routine visits of the dam and during severe rainstorms. The gage elevation should be tied into the National Geodetic Vertical Datum (NGVD).

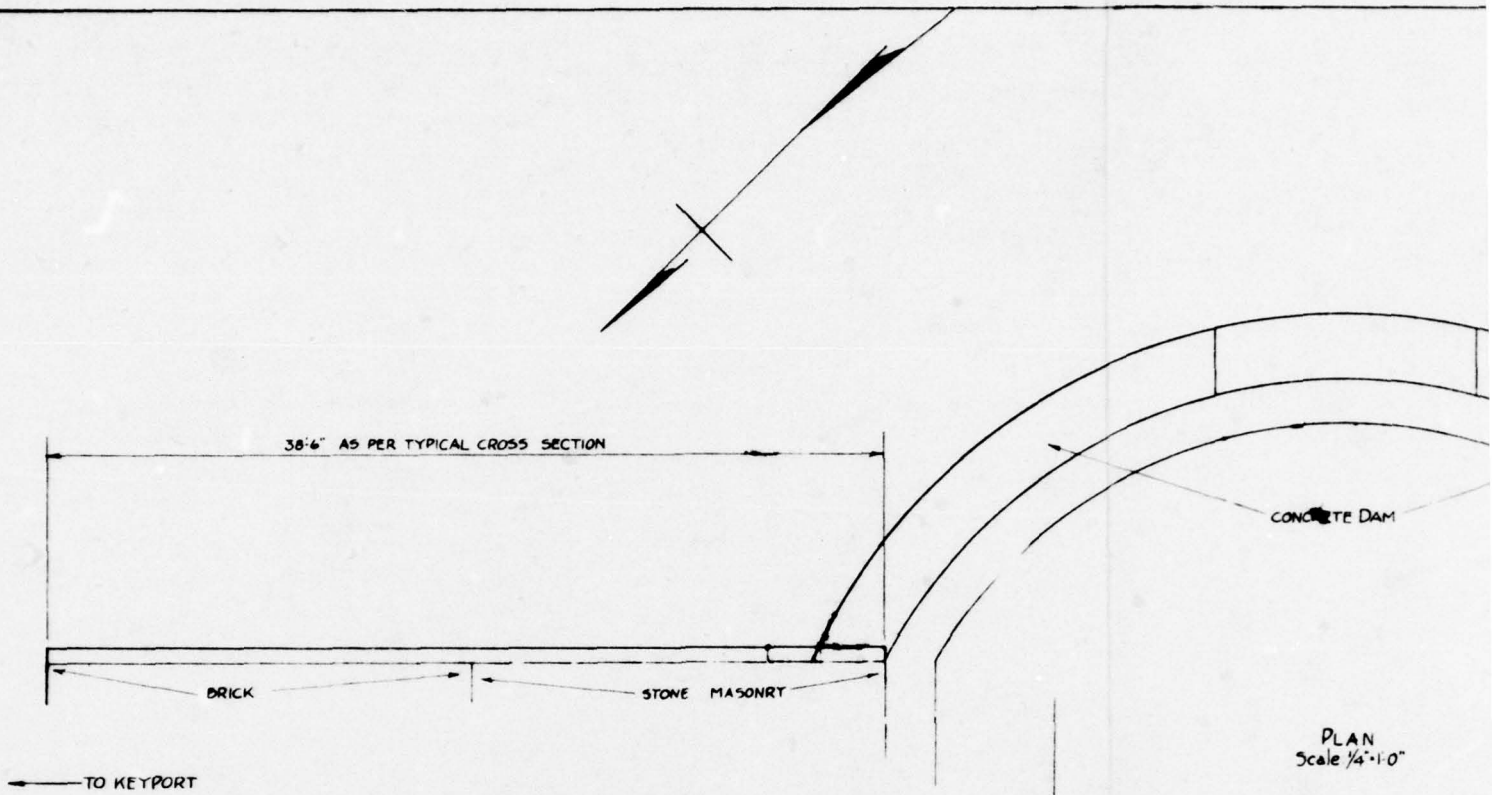
6. A rating curve for discharge over the weir and through the low level outlet should be established.

PLATES

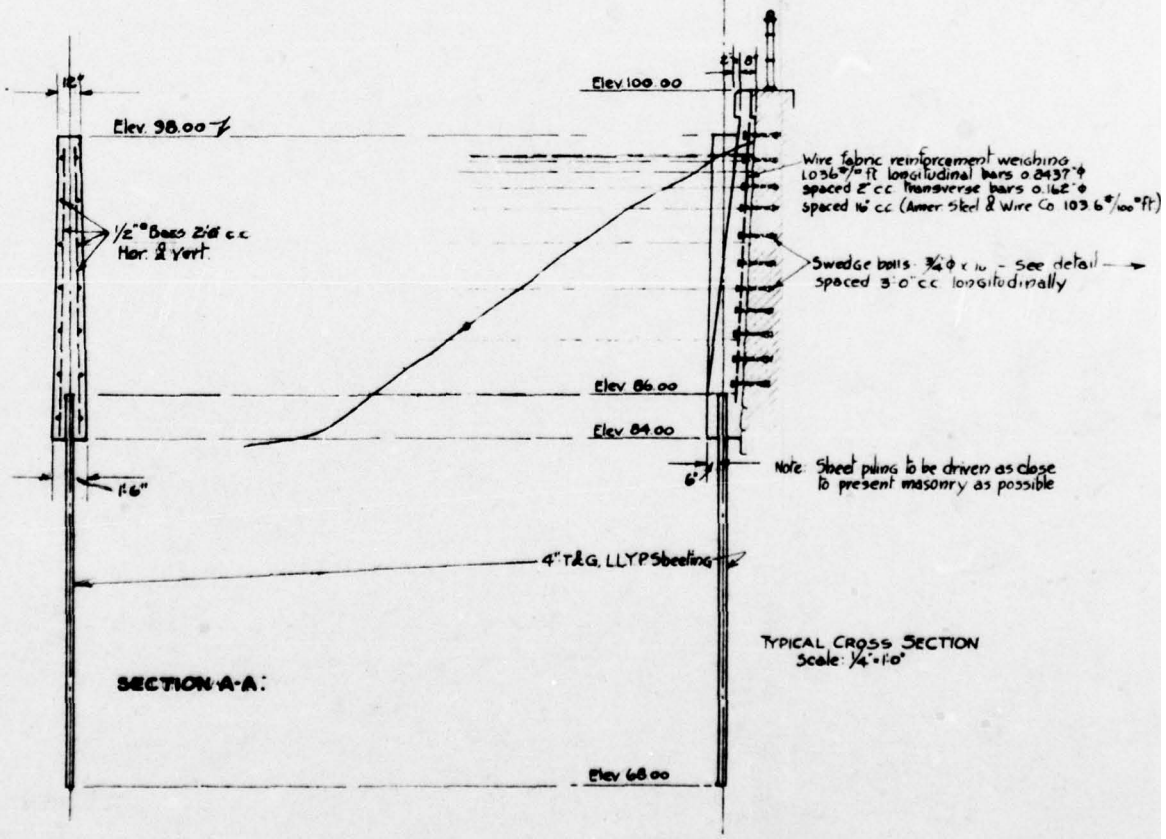
DRAWING 1



VICINITY MAP

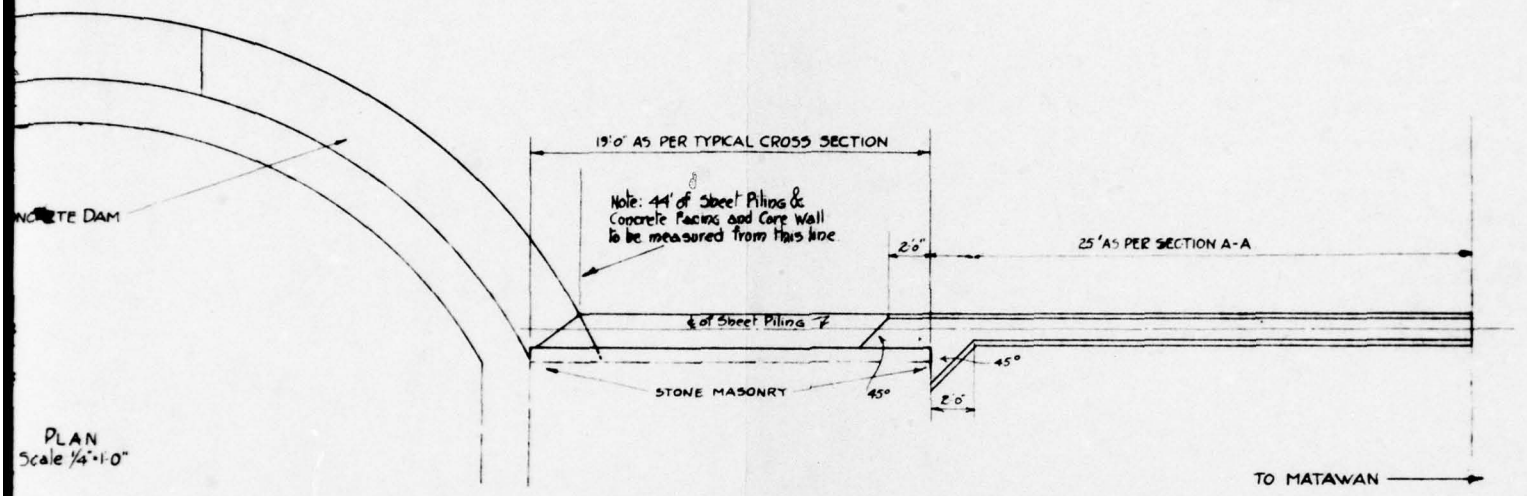


PLAN
Scale 1/4"=1'0"

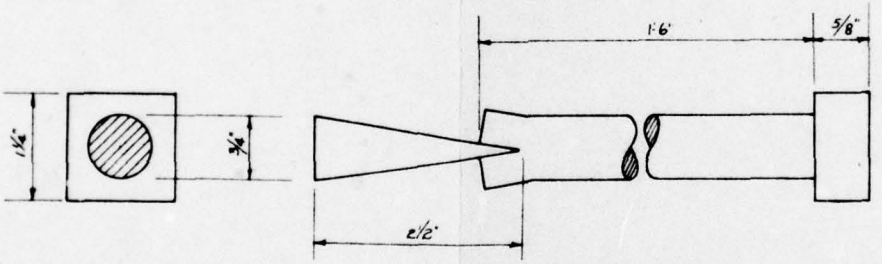


SECTION A-A:

TYPICAL CROSS SECTION
Scale: 1/4"=1'0"



PLAN
Scale ¼"=1'0"



F.S DETAIL OF SWEDGE BOLT
220 Required

APPROVED BY THE BOARD OF CHOSEN FREEHOLDERS

_____ DIRECTOR

DATE: _____ _____ CLERK

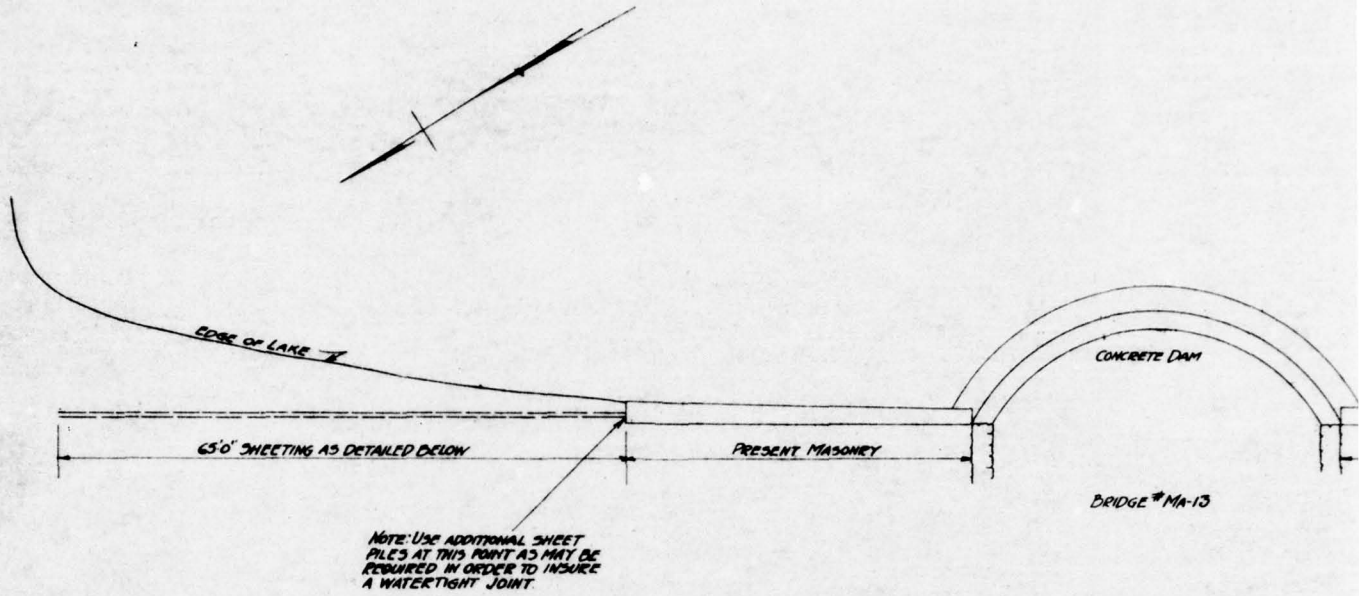
MATAWAN LAKE

DWG. NO. 2

MONMOUTH COUNTY N. J.
[illegible] K. [illegible] JR. COUNTY ENGINEER

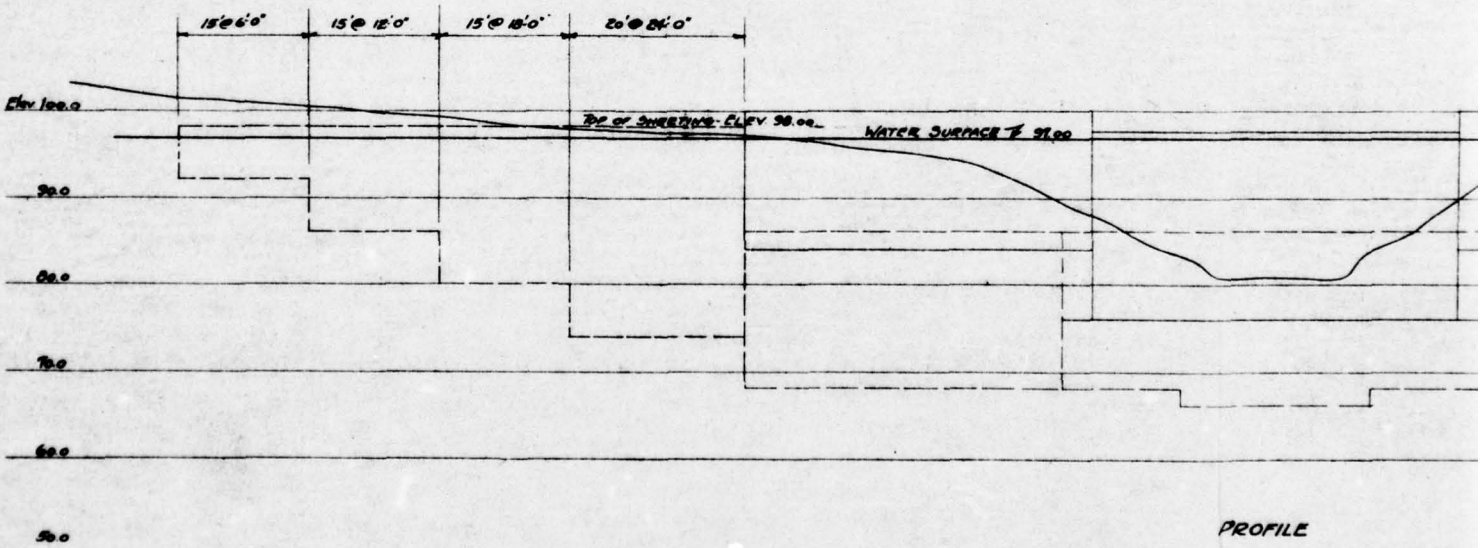
BRIDGE No. Ma-13
REPAIRS TO ABUTMENTS

SCALE: ¼"=1'0" DRAWN BY: LWL
DATE: JULY 1963 TRACED BY: LWL
CHECKED BY:
CONTRACT No. 17 SHEET NO. 1 OF 1

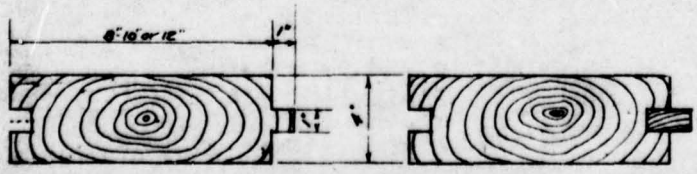


BRIDGE # MA-13

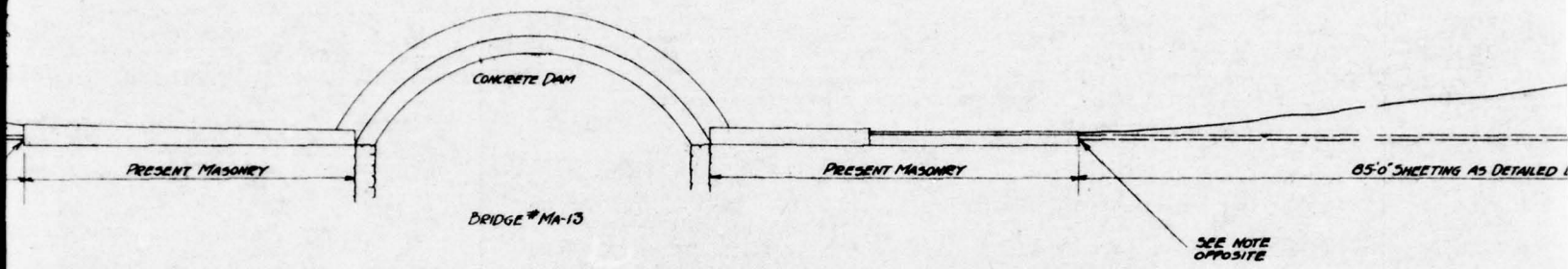
PLAN



PROFILE

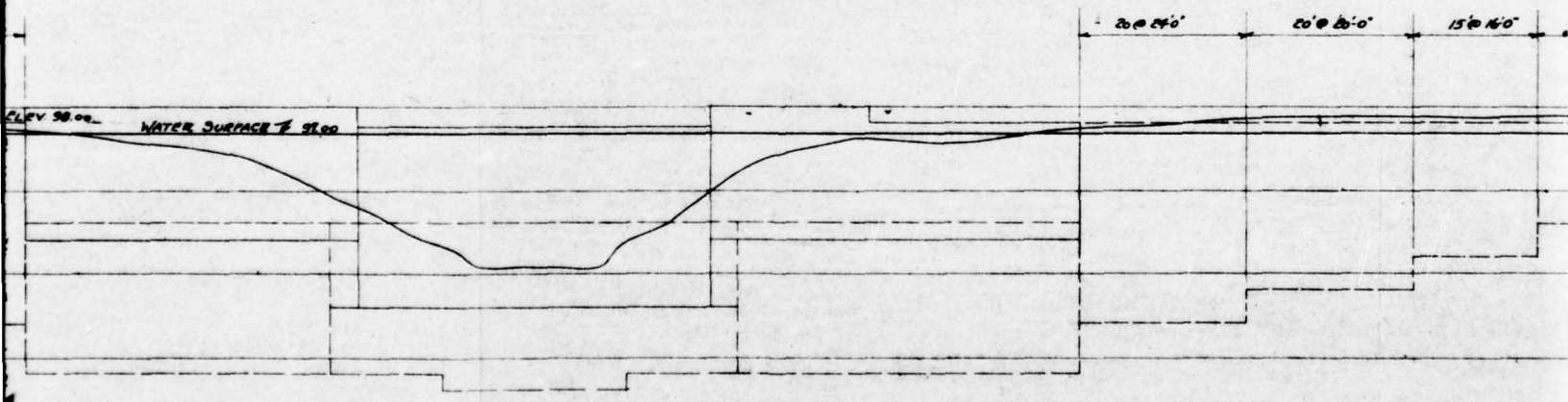


USE EITHER OF ABOVE TYPES OF SHEETING

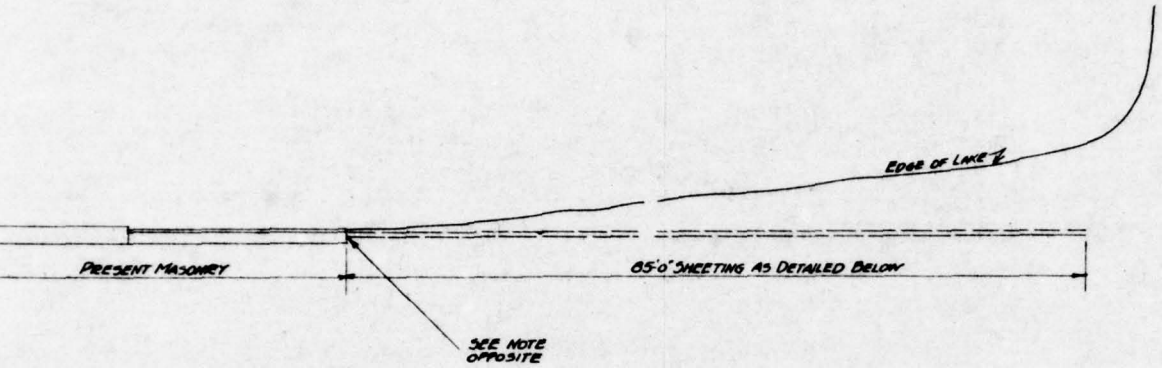


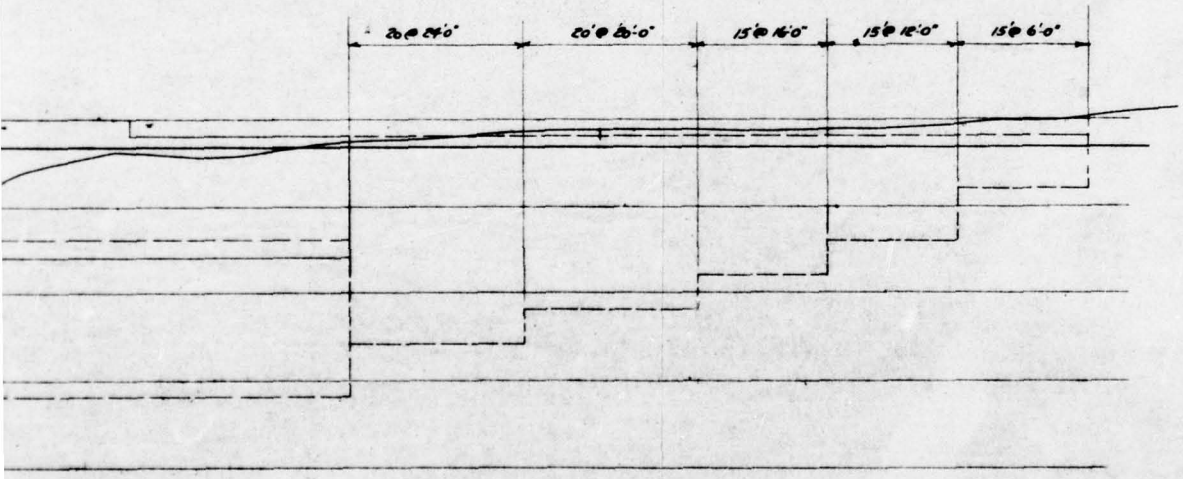
BRIDGE # MA-13

PLAN



PROFILE





MATAWAN LAKE

DWG. NO. 3

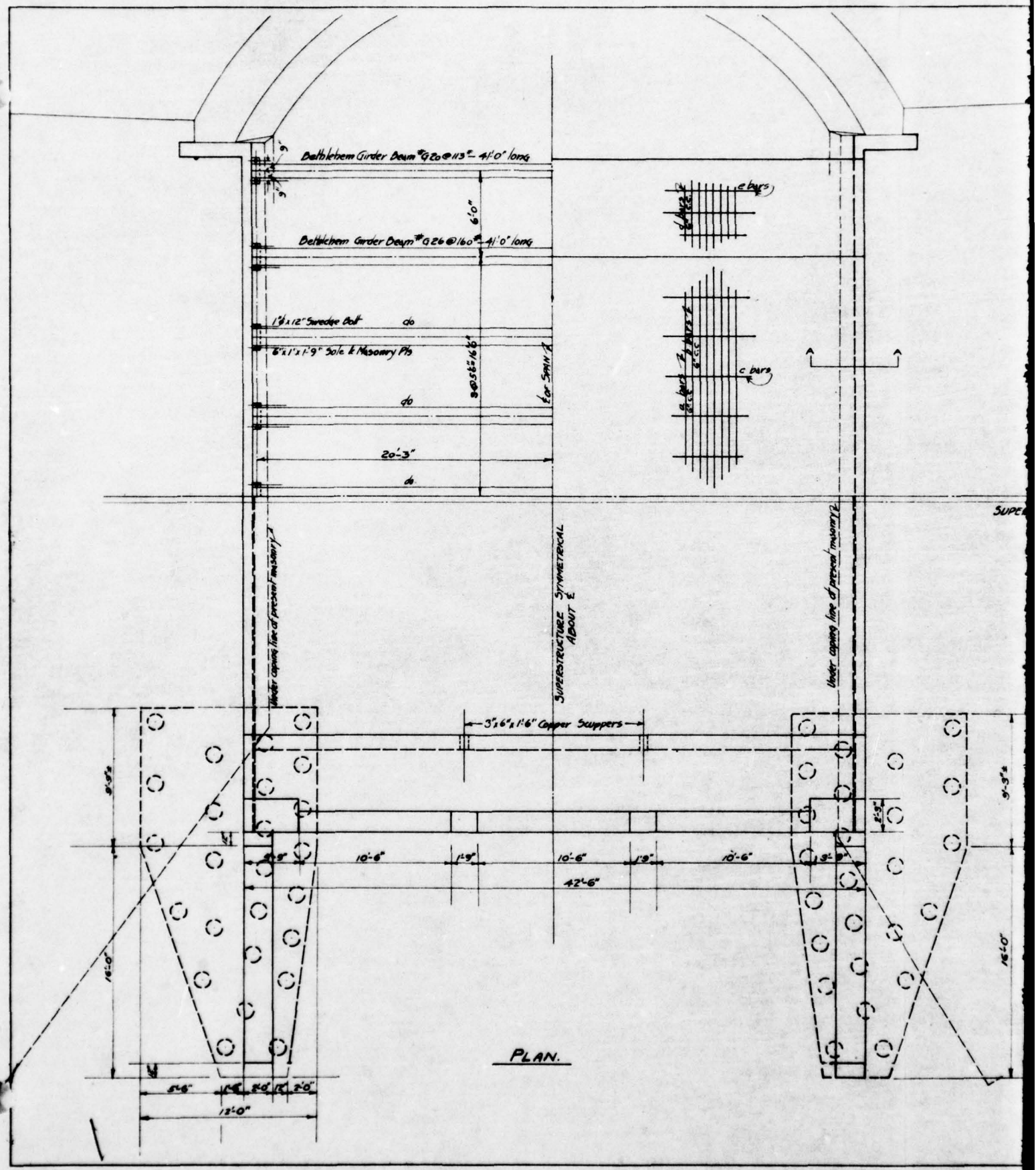
MONMOUTH COUNTY N. J.
GEORGE K. ALLEN JR. COUNTY ENGINEER

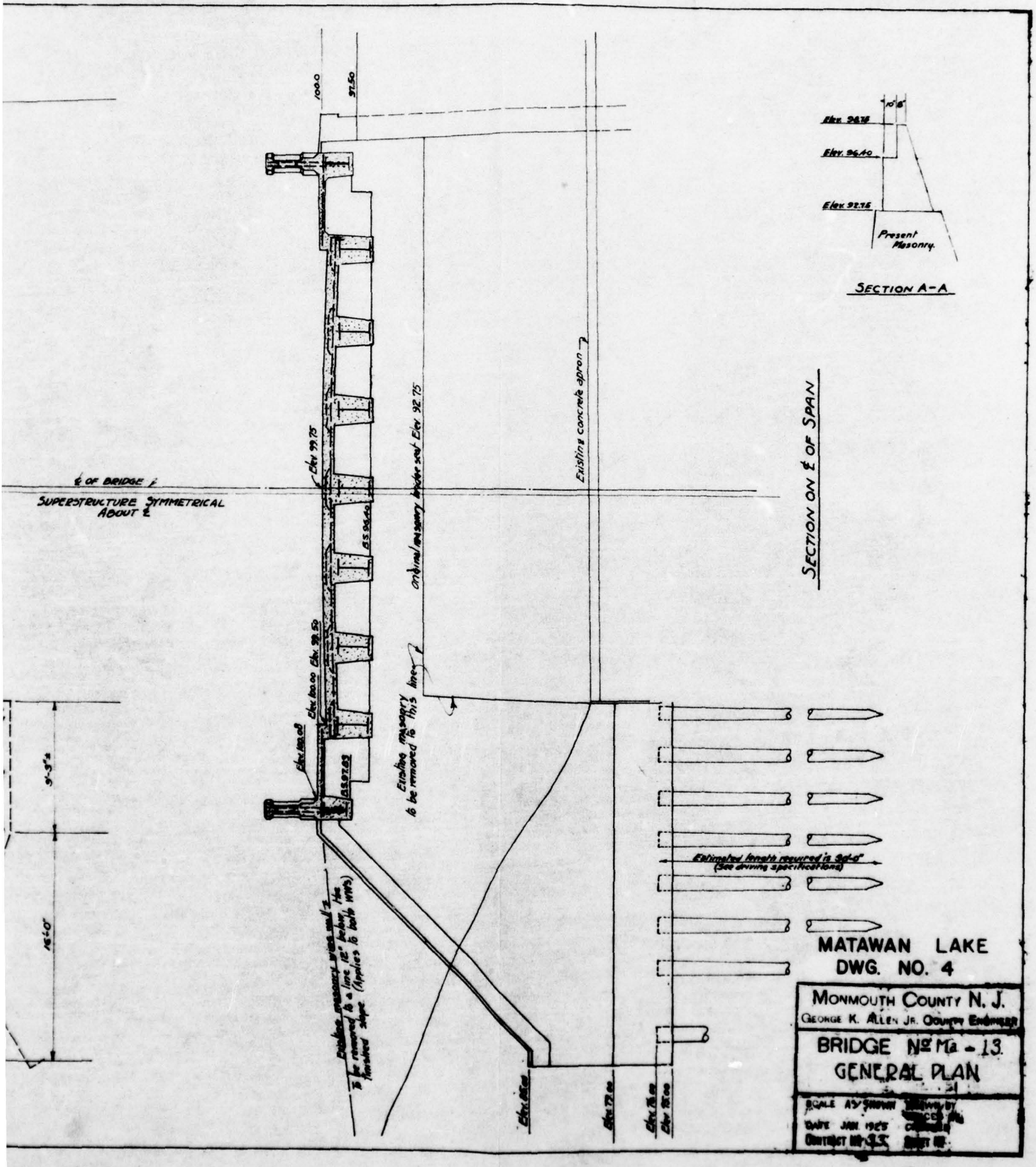
BRIDGE No MA - 13

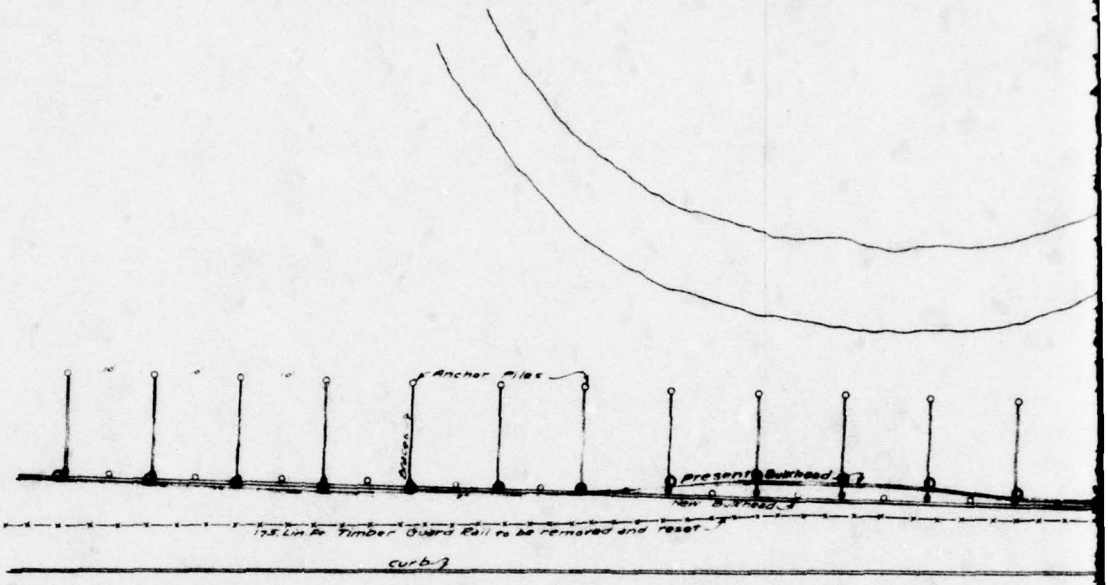
TIMBER CORE-WALL

SCALE 1" = 8'-0"
DRAWN BY LWL
TRACED BY LWL
DATE 12-7-23
CHECKED BY [illegible]
CONTRACT No [illegible]
SHEET No 1

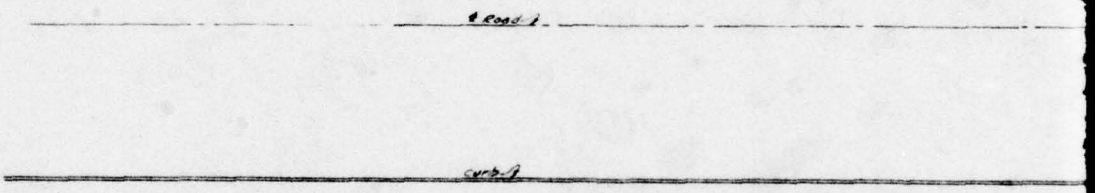
3

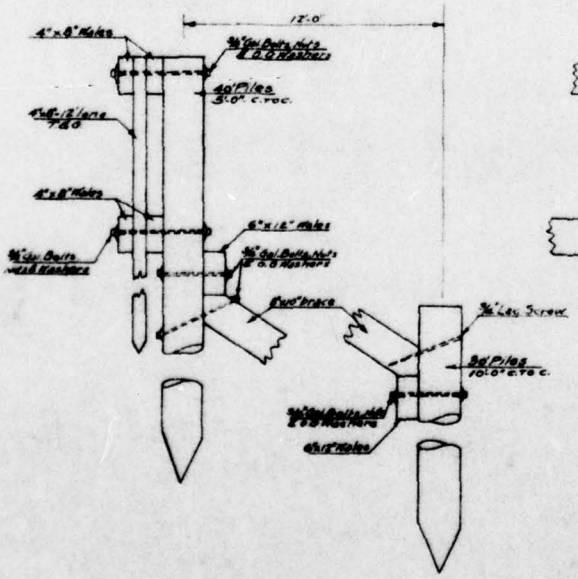

Bethlehem Girder Beam #G20 @ 113# - 41'-0" long
Bethlehem Girder Beam #G26 @ 160# - 41'-0" long
6'-0"
1 1/4" x 12" Swedge Bolt
do
6" x 1'-x 1'-9" Sole & Masonry Plts
8 @ 5 1/2" = 16'-0"
do
20'-3"
do
℄ of Span
Under coping line of present masonry
Superstructure Symmetrical About ℄
Under coping line of present masonry
3" x 6" x 1'-6" Copper Scuppers
9'-5"
9'-5"
2'-5"
2'-9"
10'-6"
1'-9"
10'-6"
1'-9"
10'-6"
3'-9"
42'-6"
16'-0"
16'-0"
5'-6"
2'-6"
2'-0"
12'-0"
PLAN.


10.00
97.50
Elev. 99.75
℄ OF BRIDGE
SUPERSTRUCTURE SYMMETRICAL ABOUT ℄
BS 93.63
Elev. 100.00 Elev. 99.50
Elev. 88.08
BS 92.62
3'-3"±
16'-0"
Existing masonry to be removed & a line 12" below the finished slope (Applies to both wings)
Original masonry bridge seat Elev. 92.75
Existing masonry to be removed to this line
Existing concrete apron
Elev. 88.63
Elev. 78.00
Elev. 75.00
Elev. 75.00
Elev. 96.38
Elev. 96.40
Elev. 92.75
Present Masonry
SECTION A-A
SECTION ON ℄ OF SPAN
Estimated length required is 36'-0"
(See driving specifications)
MATAWAN LAKE
DWG. NO. 4
MONMOUTH COUNTY N. J.
GEORGE K. ALLEN JR. COUNTY ENGINEER
BRIDGE No. Ma - 13.
GENERAL PLAN
SCALE AS SHOWN
DRAWN BY
DATE JAN. 1965
CHECKED
CONTRACT NO. 35
SHEET NO.



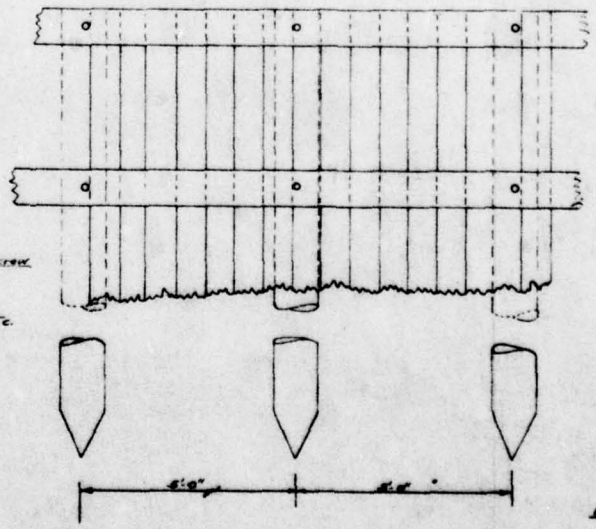
MAIN STREET





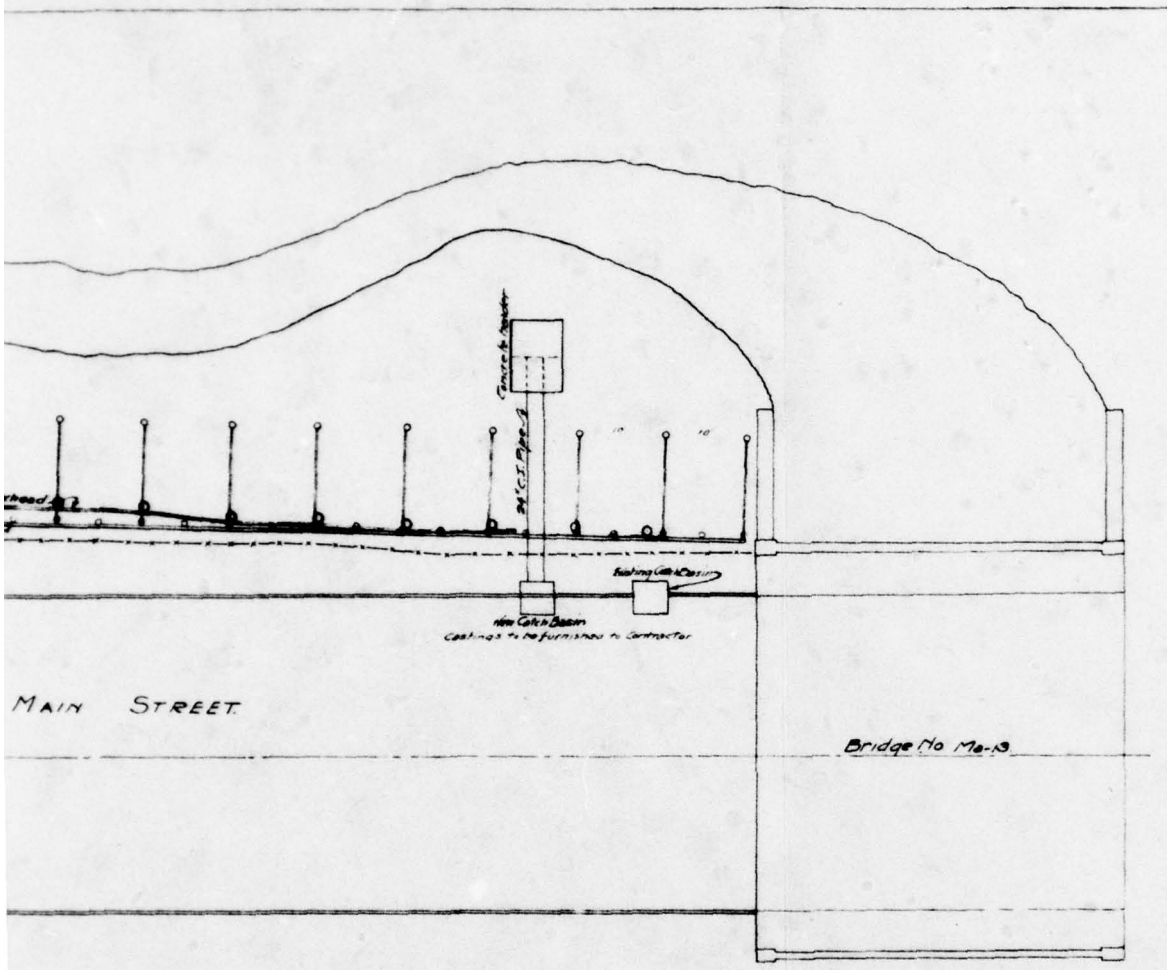
Detail of Bulkhead

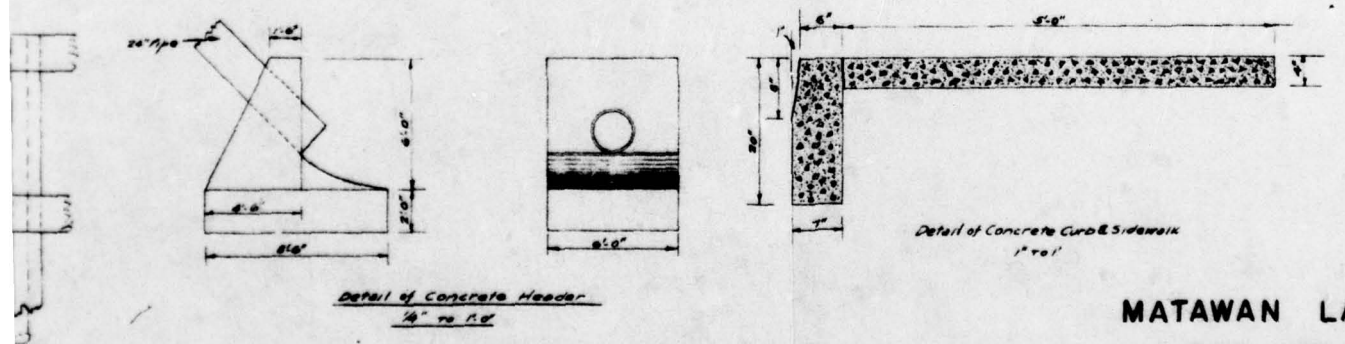
1/8" to 1'-0"



APPROVED

DATE 9/15/28 (Sign





Detail of Concrete Header
1/8" to 1'-0"

Detail of Concrete Curb & Sidewalk
1" to 1'

MATAWAN LAKE
DWG. NO. 5

APPROVED BY THE BOARD OF CHOSEN FREEHOLDERS

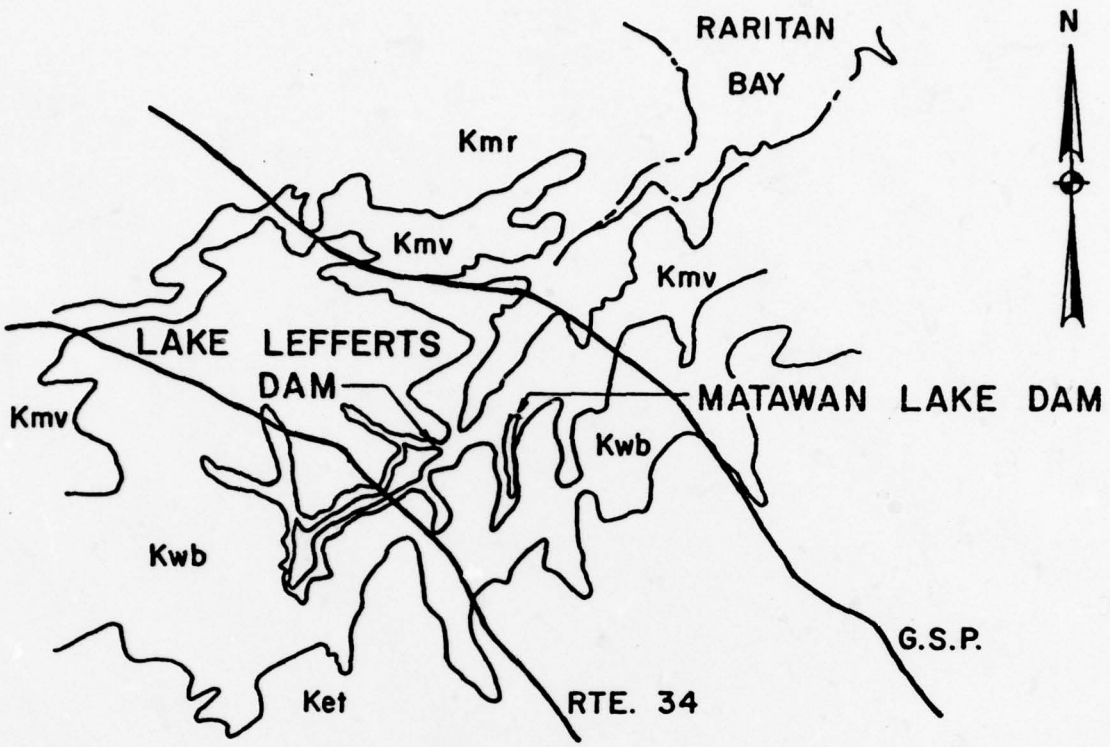
DATE 9/15/28 (Signed) Director [illegible] DIRECTOR: [illegible]

MONMOUTH COUNTY N. J.
GEORGE K. ALLEN JR. COUNTY ENGINEER

TIMBER BULKHEAD
MA - MATAWAN 13

SCALE as shown
DATE August 1928
DRAWN BY A.S.L.
TRACED BY A.S.L.
CHECKED BY G.K.A.
SHEET NO 1 OF 1

2



Scale: 1" = 1 Mile

LEGEND:

CRETACEOUS

Ket Englishtown Sand
White or Yellow Quartz and with Some Mica, and Fine Lamiae of clay.

Kwb Woodbury Clay
Dark Gray Clay

Kmv Merchantville Formation
Interstratified Glauconitic Sands and Thin Beds of Clayey Silt.

Kmr Magothy and Raritan Formations
Dark Silty Clays and Light-Colored Sands(Km); Alternating Layers of Sand and Clays(Kr)

——— Contact

GEOLOGIC MAP

LAKE LEFFERTS–MATAWAN LAKE

DWG. NO. 6

APPENDIX A

CHECK LIST - VISUAL OBSERVATIONS

CHECK LIST - ENGINEERING, CONSTRUCTION MAINTENANCE DATA

CHECK LIST
VISUAL INSPECTION
PHASE 1

Name Dam MATAWAN LAKE DAM County Monmouth State New Jersey Coordinators

Date(s) Inspection May 8, 1978 / May 10, 1978 Weather Cloudy / Clear Temperature 55°F / 65°F

Pool Elevation at Time of Inspection 18.6± M.S.L. Tailwater at Time of Inspection 2.0± M.S.L.

Inspection Personnel:

Seymour Roth, May 8 and 10
David Kerkes, May 8 and 10
William Flynn, May 8
Recorder: Seymour M. Roth

Lynn Brown, May 8
Henry King, May 10

Lawrence Woscyna, May 8
NJ-DEP

Present for Monmouth County, on May 10, 1978: Mr. William V. W. Cokelet
Assistant County Engineer

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SEEPAGE OR LEAKAGE	NA	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	NA	
DRAINS	NA	
WATER PASSAGES	NA	
FOUNDATIONS	NA	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	NA	
STRUCTURAL CRACKING	NA	
VERTICAL & HORIZONTAL ALIGNMENT	NA	
MONOLITH JOINTS	NA	
CONSTRUCTION JOINTS	NA	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No surface cracking observed. Top of embankment is paved as a two-lane highway, named Main Street.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Part of roadway fill on downstream left abutment embankment is supported for the top 6 feet by vertical timber piles and timber sheeting. These piles are tied back into the embankment. Several timber piles have moved foward approx. 12 in. and the tie back rod has pulled through the face of the pile. The first 5 piles to the left of the bridge have been reinforced by an additional row of kicker piles in front of the primary row of retaining wall piles and connected by a sloping timber strut. Timber retaining wall system is in deteriorated condition, piles are rotted through.	Replace rotten piles, if the embankment slope is not fully extended right to the roadway elevation.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Downstream left embankment slope is very steep below the retaining wall system, very irregularly graded, locally sloughed and eroded and covered by brush in a wild state. Toe of slope ends right in the downstream channel, which turns left 90 degrees after coming out of the spillway bridge and runs parallel to the embankment.	Clear downstream slope, regrade and flatten. Plant with vegetative cover to stabilize against erosion. Rechannel downstream creek (see "Downstream Channel")
VERTICAL & HORIZONTAL ALIGNMENT OF THE CREST	The crest of the roadway embankment is on a slight curve and on grade. The roadway is excessively crowned because of loss of ground under the downstream lane.	
RIPRAP FAILURES	No riprap has been installed.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No signs of leakage or loss of ground.	
ANY NOTICEABLE SEEPAGE	Seepage observed on embankment slope below top timber retained portion, approximately 10 feet downstream of wall starting at a point two feet to left of bridge and extending into the left abutment contact. Flow is minimal, water is clear. Some seepage observed at base of one of the timber piles supporting the retaining wall at top of embankment.	Seepage not considered serious. Treat seepage in conjunction with slope flattening and/or extension to roadway level.
STAFF GAGE AND RECORDER	None observed	
DRAINS	None observed	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CRACKING & SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Some concrete deterioration observed in the 36-inch hole in the spillway forming the low level outlet passage.	
INTAKE STRUCTURE	NA	
OUTLET STRUCTURE	Facilities consist of a 36-inch diameter gate valve mounted on the upstream face of the semi-circular spillway and operated from a valve stand on top of the spillway. Gate is inoperable.	The low level outlet should be made operational from the sidewalk area of the bridge.
OUTLET CHANNEL	Water passing over semi-circular gate passes under the spillway bridge which has a paved invert, from there into the natural channel of Gravelly Brook.	
EMERGENCY GATE	None provided.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE WEIR	Semi-circular concrete spillway 36-inch wide at top with a center notch 12-foot long by 6- inch deep (approximately). Spillway ties into bridge abutments. Concrete surface on downstream face in fair serviceable condition. Lift lines are cracked. A massive splash pad is placed directly under the spillway notch.	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	Spillway discharge flows directly under spillway bridge.	
BRIDGE AND PIERS	Left bridge abutment of masonry and concrete construction has settled and cracked. The left downstream wingwall is cracked on top. Single span bridge with reinforced concrete encased beam superstructure was built in 1925.	Investigate causes of left abutment settlement and cracking.

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE SILL	NA	
APPROACH CHANNEL	NA	
DISCHARGE CHANNEL	NA	
BRIDGE AND PIERS	NA	
GATES & OPERATION EQUIPMENT	NA	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
MONUMENTATION/ SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	Establish lake level gage on upstream face of bridge. Establish spillway rating curve.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENTATIONS
SLOPES	Reservoir rim upstream of Main Street is fairly steep, 1 vertical on 2 or 3 horizontal, directly to water line. There is no shoreline protection.	
SEDIMENTATION	Reservoir has silted extensively and is significantly shorter now than at time of first filling.	Siltation can affect any routing procedure which rises lake storage below spillway crest level.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Downstream channel is in a wide tidal flood plain. Gravelly Brook joins Matawan Creek a short distance downstream. There are no obstructions but the brook channel meanders, and forms a loop in the left direction. The channel turns 90 degrees to left downstream of the spillway bridge and runs parallel to the embankment endangering the stability of the embankment slope	Consider realignment of the downstream channel by elimination of the existing loop. New channel to run approx. perpendicular to dam axis. Consider riprap channel bottom and slope protection for first 60-80 ft. if needed for channel stabilization.
SLOPES	The channel has relatively low banks in a wider tidal flood plain.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	No homes or businesses in the downstream tidal flat. Whatever dwellings there are, are located on the top of the tidal flat banks at an approximate elevation equal to the crest of the dam. The embankment of the N.Y. & Long Branch railroad acts as a barrier, protecting further downstream areas.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	No full plan available for entire dam. Partial plans exist for the timber sheeting cutoff, the bridge abutments and the spillway.
REGIONAL VICINITY MAP	Available
CONSTRUCTION HISTORY	No formal history exists,but can be deduced from available plans and drawings.
TYPICAL SECTIONS OF DAM	Not available.
HYDROLOGIC/HYDRAULIC DATA	No existing data on the ungaged brook.
OUTLETS - PLAN	Available
- DETAILS	None available
- CONSTRAINTS	None
- DISCHARGE RATINGS	Not available
RAINFALL / RESERVOIR RECORDS	Not available

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available
POST-CONSTRUCTION SURVEYS OF DAM	None available
BORROW SOURCES	Unknown
SPILLWAY PLAN - SECTIONS - DETAILS	Available, but due to poor quality, not reproduced in this report.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
OPERATING EQUIPMENT PLANS AND DETAILS	None available
MONITORING SYSTEMS	None
MODIFICATIONS	Embankment modified at top by addition of a timber retaining wall in 1928
HIGH POOL RECORDS	Not kept
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OF FAILURE OF DAM - DESCRIPTION - REPORTS	None uncovered
MAINTENANCE OPERATION RECORDS	None uncovered

APPENDIX B

PHOTOGRAPHS

PHOTOGRAPHS TAKEN DURING MAY 1978

Photo 1 - General view of the downstream face of the roadway embankment, looking toward the left abutment

Photo 2 - General view of the downstream face of the roadway embankment, looking toward the right abutment

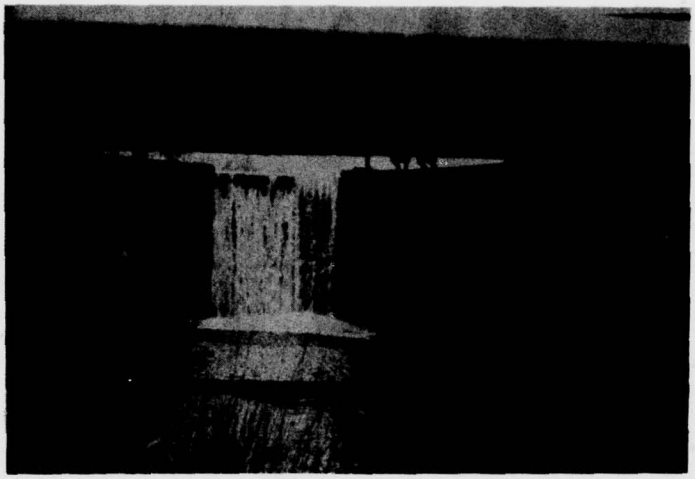


Photo 3 - View of the semi-circular weir from downstream showing the low flow notch in the weir; the low level outlet pipe is to the right of the overflow cascade

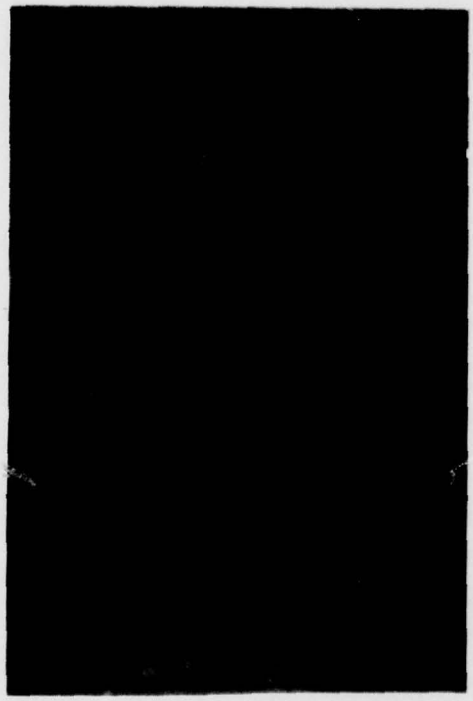


Photo 4 - View of the low level outlet gate valve operator

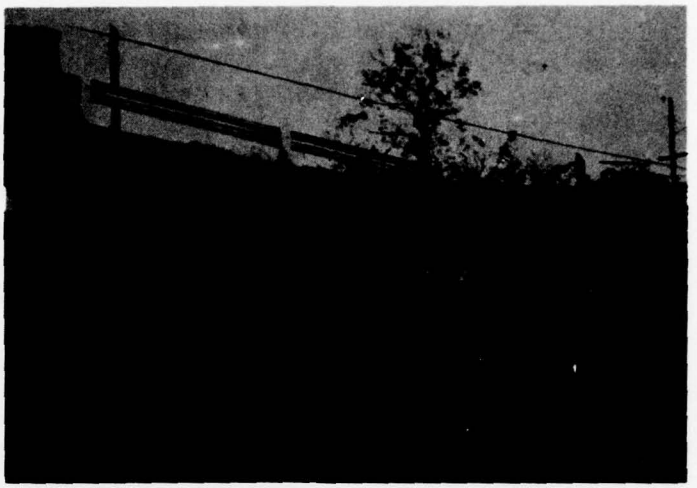


Photo 5 - View of the downstream face embankment retaining wall consisting of piles, sheeting, downstream kicker piles and connecting struts, located to the left of the bridge

Photo 6 - Downstream face of the left embankment retaining wall showing a section to the left of Photo 5; the kicker piles have been discontinued, and the vertical piles have been tied back into the embankment; the tie rod on the near pile has pulled through the deteriorated wood

Photo 7 - View of the downstream channel, running parallel at the toe of the left embankment section before turning downstream

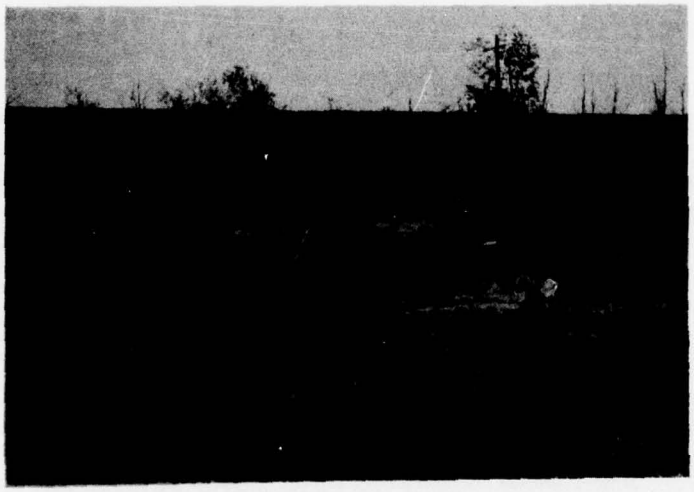


Photo 8 - Culverts passing through a high railroad embankment controlling the tail water for both Matawan Lake and Lake Lefferts Dams

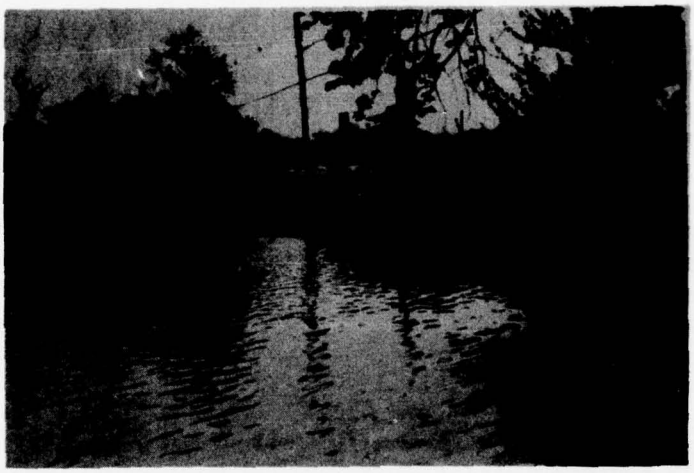


Photo 9 - Upstream view of the roadway embankment and weir, looking toward the left abutment

Photo 10 - General view of the downstream face of the roadway embankment, looking toward the right abutment; the downstream stream channel is obscured by vegetation, but it runs parallel to the embankment toe of slope.

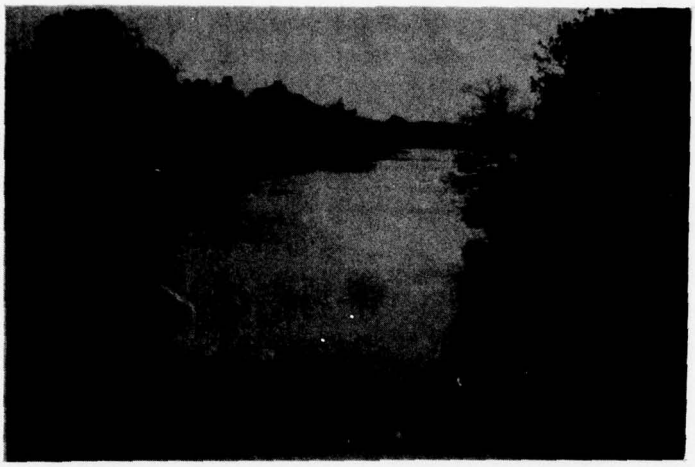


Photo 11 - View of Matawan Lake from the Little Street bridge crossing, looking toward the dam

Photo 12 - View of the dry and silted in upper part of Matawan Lake upstream of the N.J. Central railroad trestle

APPENDIX C

SUMMARY OF ENGINEERING DATA

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

Name of Dam: MATAWAN LAKE DAM

Drainage Area Characteristics: 2.7 square miles on Gravelly Brook

Elevation Top Normal Pool (Storage Capacity): 18.27 (280)

Elevation Top Flood Control Pool (Storage Capacity): NA

Elevation Maximum Design Pool: 21.27

Elevation Top Dam: Earth embankment (Main Street) 21.27

SPILLWAY CREST:

a. Elevation 12 foot section at Elev.18.27, remainder at Elev. 18.77
b. Type Uncontrolled concrete arch weir
c. Width 3 feet
d. Length 57 feet
e. Location Spillover Mid-section of dam
f. No. and Type of Gates NA

OUTLET WORK:

a. Type One 36-inch diameter low level outlet
b. Location On left side of spillway weir
c. Entrance Inverts 3.02
d. Exit Inverts 3.02
e. Emergency Draindown Facilities As above

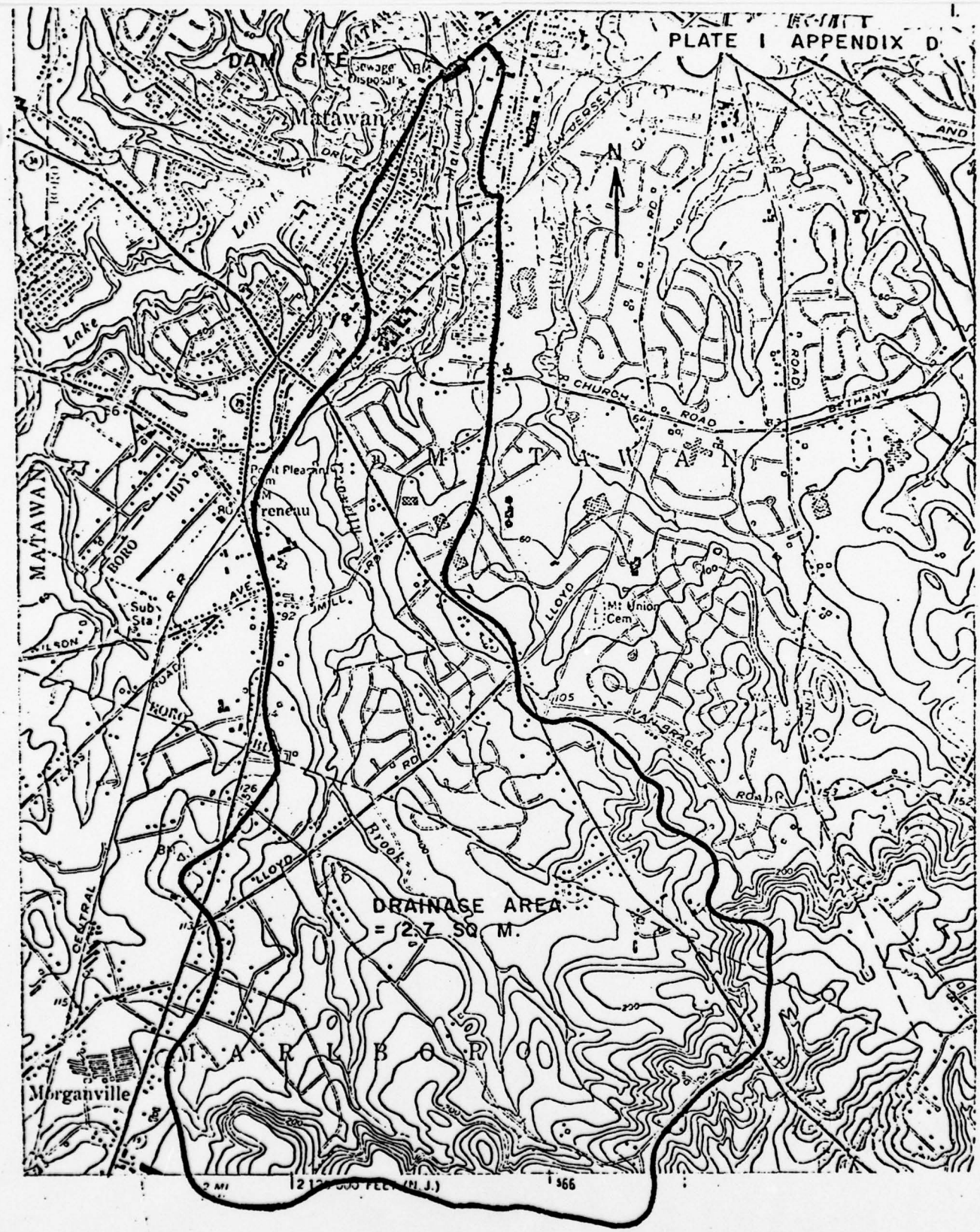
HYDROMETEOROLOGICAL GAGES:

a. Type None
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE Estimated at 1,000 cfs

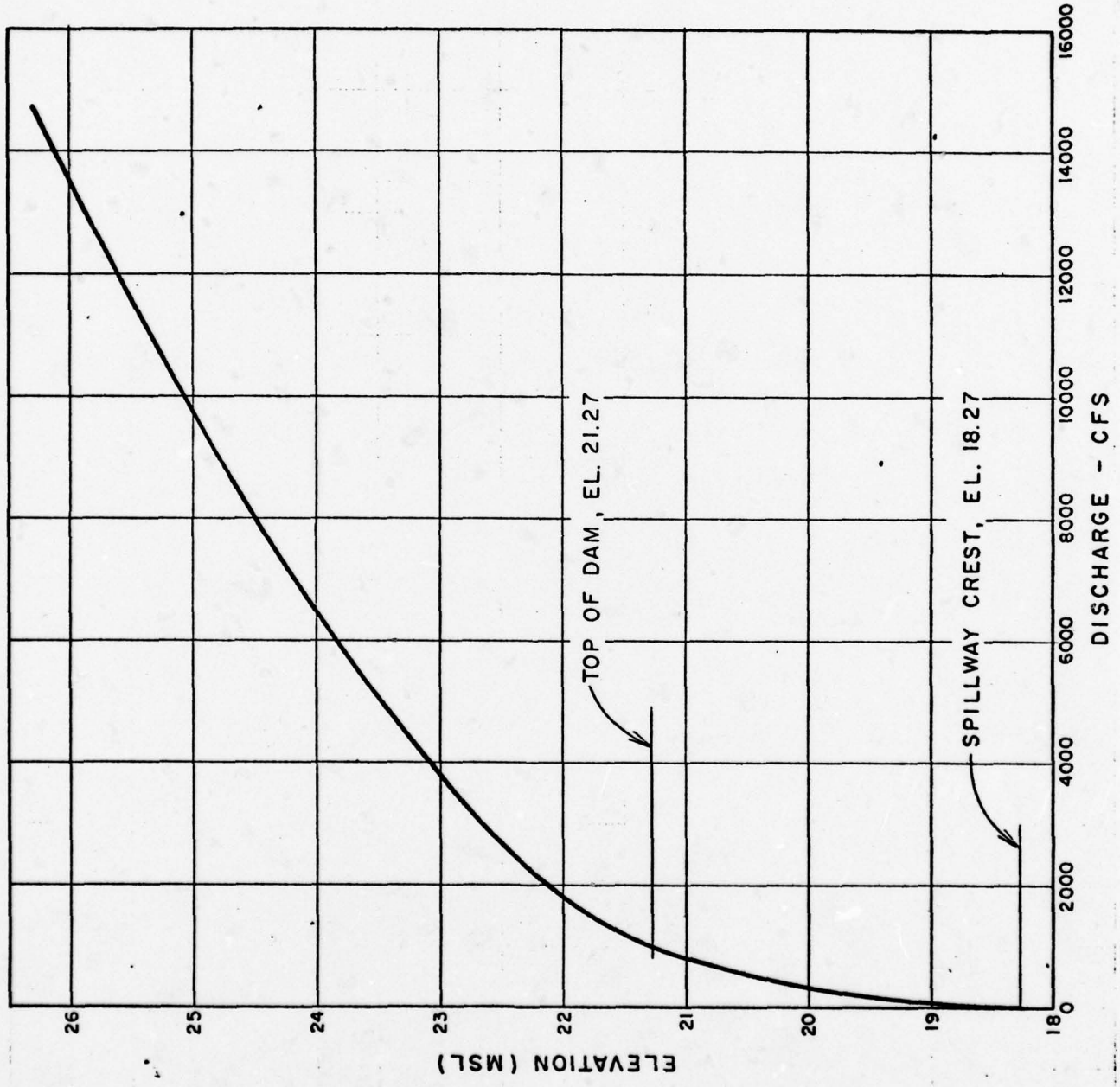
APPENDIX D

HYDROLOGIC COMPUTATIONS

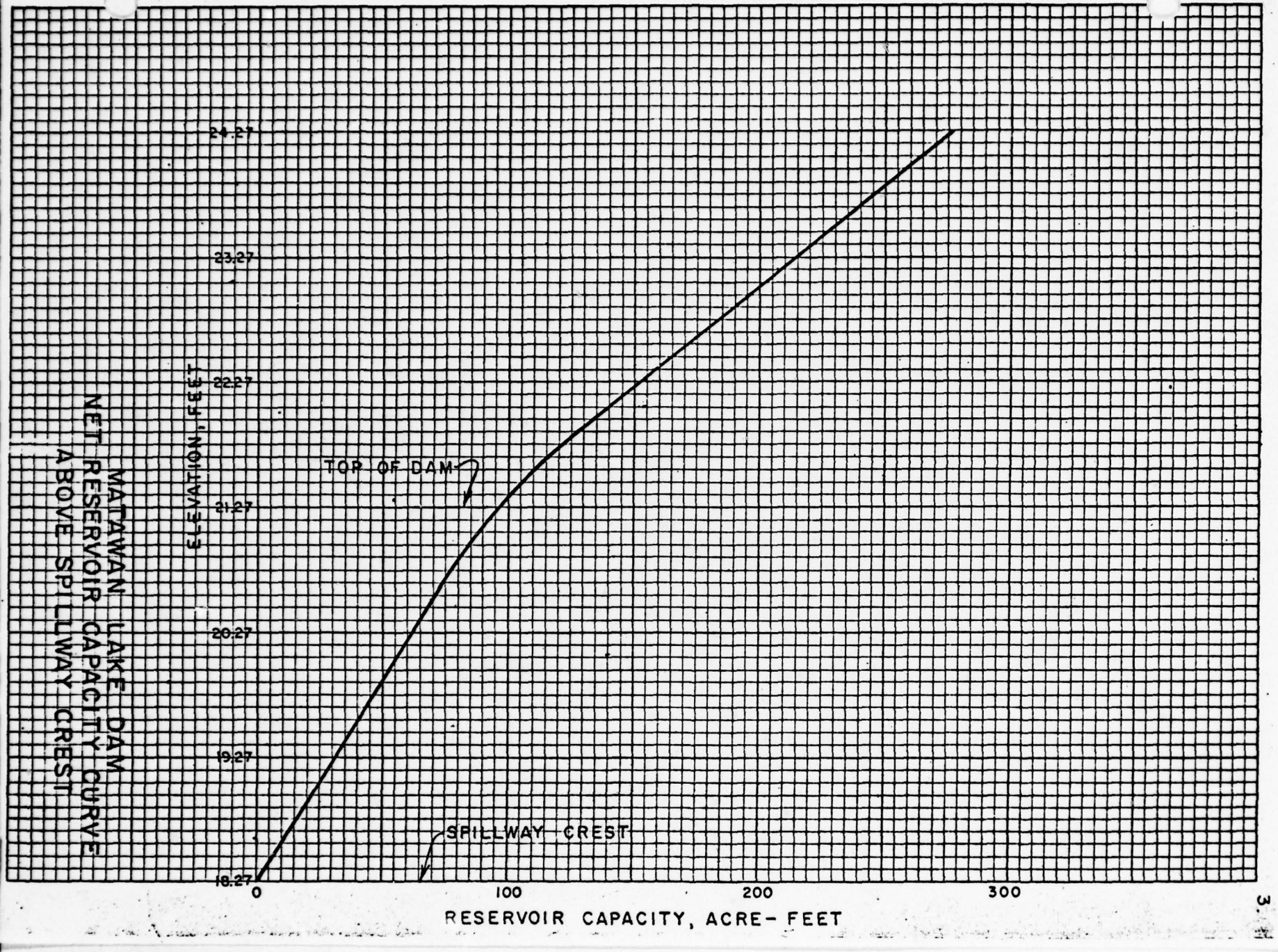


MATAWAN LAKE DAM
DRAINAGE BASIN

PLATE 2 APPENDIX D

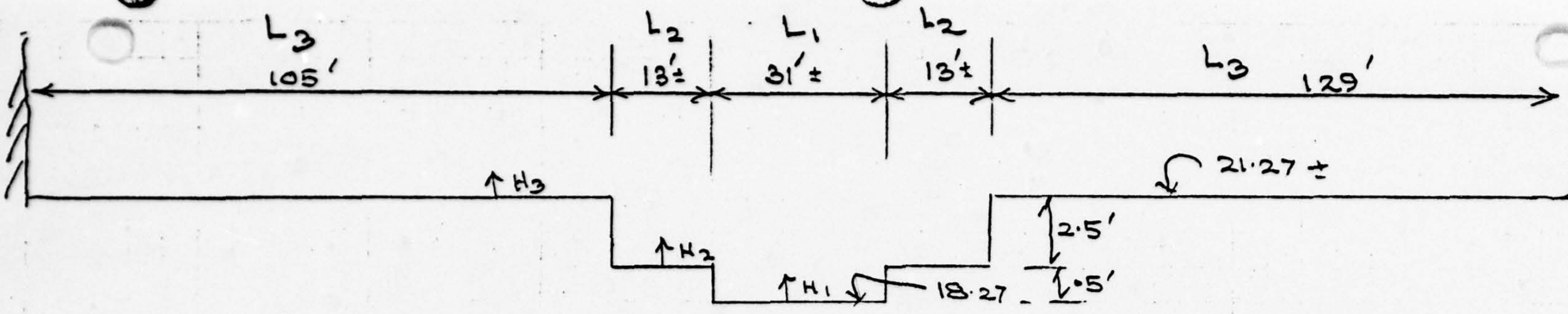


MATAWAN LAKE DAM
SPILLWAY RATING CURVE


MATAWAN LAKE DAM
NET RESERVOIR CAPACITY CURVE
ABOVE SPILLWAY CREST
ELEVATION, FEET
24.27
23.27
22.27
21.27
20.27
19.27
18.27
TOP OF DAM
SPILLWAY CREST
0
100
200
300
RESERVOIR CAPACITY, ACRE-FEET

Matawan Dam

Spillway & Overtop Rating Curve



$$Q = C_1 L_1 H_1^{1.5} + C_2 L_2 H_2^{1.5} + C_3 L_3 H_3^{1.5}$$

El.	H_1	H_2	H_3	L_1	L_2	L_3	C_1	C_2	C_3	Q	
Spillway Crest at El 18.27	0										
18.77	0.5	0		31			3.1			34+0+0	= 34
19.27	1.0	.5		31	26		3.2	3.1		99+29+0	= 128
19.77	1.5	1.0		31	26		3.3	3.2		188+83+0	= 271
20.27	2.0	1.5		31	26		3.4	3.3		298+158+0	= 456
20.77	2.5	2.0		31	26		3.5	3.4		429+250+0	= 679
21.27	3.0	2.5	0	31	26	0	3.6	3.5		580+360+0	= 940 rounded ±1000 cfs
21.77	3.5	3.0	0.5	31	26	234	3.6	3.6	3.1	731+486+256	= 1,473
22.77	4.5	4.0	1.5	31	26	234	3.7	3.7	3.3	1095+770+1419	= 3,284
23.27	5.0	4.5	2.0	31	26	234	3.8	3.7	3.4	1317+918+2250	= 4,485
24.77	6.5	6.0	3.5	31	26	234	3.8	3.8	3.6	1952+1452+5516	= 8,920
26.27	8.0	7.5	5.0	31	26	234	3.8	3.8	3.8	2666+2029+9942	= 14,637

ECI-4 ENGINEERING CONSULTANTS, INC.

NEW JERSEY DAM SAFETY INSPECTION SHEET NO. 1 OF 1
MATAWAN LAKE DAM JOB NO. 1209-001
RESERVOIR AREA CAPACITY DATA BY JMAS DATE July 7

MATAWAN LAKE DAM

RESERVOIR AREA CAPACITY DATA

SUMMARY

Elevation (Feet)	Reservoir Surface Area (Acres)	Reservoir Volume (AC-FT)	Net Vol. of Reservoir Above Spillway Crest (AC-FT)	Remarks
18.27	28	280	0	Estimated area at El 18.27 is about 28 acres. The Normal Capacity of 280 A-F is assumed at this elev. (Spill-way Crest).
19.77	33±	326	46	Assuming a maximum capacity of 326±A-F at 1.5 ft above Spillway Crest
21.27	38±	379	99	
24.27	48±	508	228	

b.

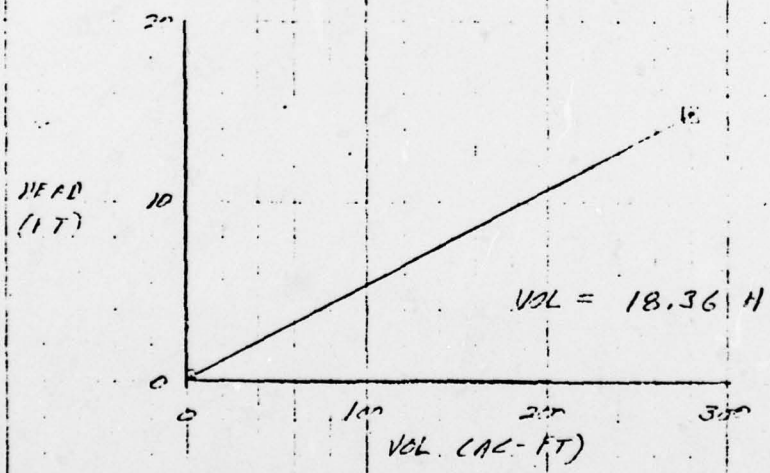
a) DISCHARGE VS. HEAD (FROM PREVIOUS WORK)

$Q = 37.37\sqrt{H}$

b) STORAGE VS. HEAD

ASSUME A STRAIGHT LINE RELATIONSHIP FROM NORMAL WATER SURFACE VOLUME TO ZERO VOLUME AT ZERO HEAD

	ELEV. (FT)	HEAD (FT)	VOL. (AC-FT)
NWS.	18.27	15.25	280
TOP OF OUTLET	3.02	0	0



c) DRAINAGE AREA = 2.7 SQ. MI.

INFLOW = 2 CFS/SQ. MI. X 2.7 SQ. MI. = 5.4 CFS

d) RESERVOIR EVACUATION TIME WITH CONSTANT INFLOW
= 46 HR
(FROM COMPUTER PRINTOUT) = 1.92 DAYS

e) RESERVOIR EVACUATION TIME WITH ZERO INFLOW
= 40 HR
(FROM COMPUTER PRINTOUT) = 1.67 DAYS

SHEET NO. 7.

RESERVOIR EVACUATION

WITH CONSTANT INFLOW

JOB NO.

BY DATE

HEAD (FT)	VOLUME (AC-FT)	TOTAL DISCHARGE (CFS)	INFLOW (CFS)	AVAILABLE DISCHARGE (CFS)	EVACUATION TIME (HR)
15.25					
	22.96	150.56	5.4	145.16	1.91
14.00					
	36.72	141.95	5.4	136.55	3.25
12.00					
	36.72	130.58	5.4	125.18	3.55
10.00					
	36.72	118.11	5.4	112.71	3.94
8.00					
	36.72	104.16	5.4	98.76	4.50
6.00					
	36.72	88.03	5.4	82.63	5.38
4.00					
	36.72	68.19	5.4	62.79	7.08
2.00					
	36.72	39.37	5.4	33.97	13.08
0.00					
TOTALS	280.0	—	—	—	42.69 HR

SHEET NO. 8.

RESERVOIR EVACUATION

WITH FEED INFLOW

JOB NO. 1209-001-1

BY KLE DATE 7-1

C.A.

HEAD (FT)	VOLUME (AC-FT)	TOTAL DISCHARGE (CFS)	EVACUATION TIME (HR)
15.25			
	22.96	150.56	1.85
14.00			
	36.72	111.95	3.13
12.00			
	36.72	130.58	3.40
10.00			
	36.72	118.11	3.76
8.00			
	36.72	104.16	4.27
6.00			
	36.72	89.03	5.05
4.00			
	36.72	68.19	6.52
2.00			
	36.72	39.37	11.29
0.00			
TOTALS	280.00	—	39.72 HR

ECI-4 ENGINEERING CONSULTANTS, INC.

MCDOWELL LAKE DAM
RESERVOIR EVACUATION
WITH CONSTANT INFLOW

SHEET NO. 2 OF 3
JOB NO. [illegible]
BY [illegible] DATE [illegible]
C.D

HEAD (FT)	VOLUME (AC-FT)	TOTAL DISCHARGE (CFS)	INFLOW (CFS)	AVERAGE DISCHARGE (CFS)	EVACUATION TIME (HR)
15.25					
	22.96	150.56	5.4	145.16	1.91
10.00					
	36.72	141.95	5.4	136.55	3.25
12.00					
	36.72	130.58	5.4	125.18	3.55
10.00					
	36.72	118.11	5.4	112.71	3.94
8.00					
	36.72	104.16	5.4	98.76	4.50
6.00					
	36.72	88.03	5.4	82.63	5.53
4.00					
	36.72	68.19	5.4	62.79	7.08
2.00					
	36.72	39.37	5.4	33.97	13.08
0.00					
TOTALS	280.0	—	—	—	42.69 HR

ECI-4 ENGINEERING CONSULTANTS, INC.

NAIAWIN LAKE DAM
RESERVOIR EVACUATION
WITH PEAK INFLOW

SHEET NO. 3 OF 3
JOB NO. 1209-001-1
BY K/E DATE 7-12-

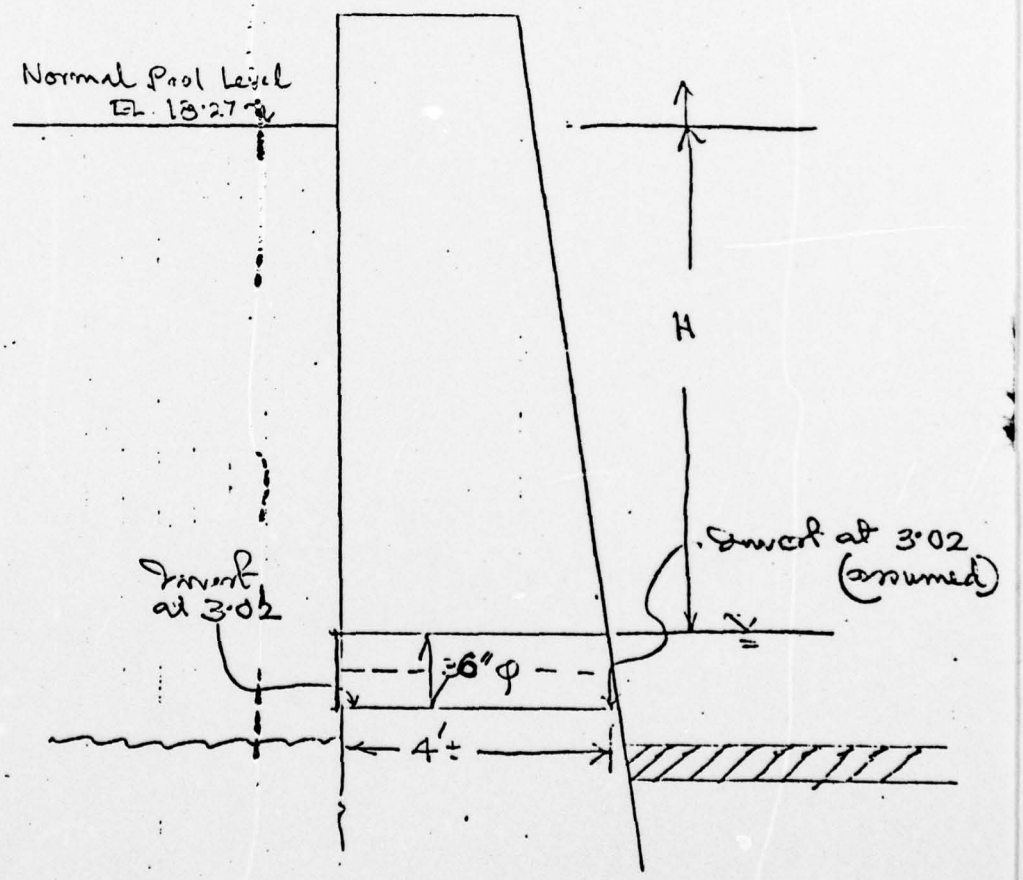
HEAD (FT)	VOLUME (AC-FT)	TOTAL DISCHARGE (CFS)	EVACUATION TIME (HR)
15.25			
	22.96	150.56	1.85
14.00			
	36.72	141.95	3.13
12.00			
	36.72	130.58	3.40
10.00			
	36.72	118.11	3.76
8.00			
	36.72	104.16	4.27
6.00			
	36.72	89.03	5.05
4.00			
	36.72	68.19	6.52
2.00			
	36.72	39.37	11.29
0.00			
TOTALS	280.00	—	39.72 HR

OUTLET CAPACITY BY JMM3 DATE 6-6

MATAWAN LAKE DAM

Outlet Works

1. Dimensions: (from drawings, April 10, 1922)



2. Determination of Outlet Capacity

Assumption:

1. Outlet is submerged and downstream water surface is just at the top of downstream end of the pipe
2. Neglect friction loss.
3. Assume $K_e = 0.5$

Solution:

$$H = (K_e + 1)\frac{V^2}{2g} = 1.5\frac{V^2}{2g}$$

$$\therefore V = 0.82\sqrt{2gH}$$

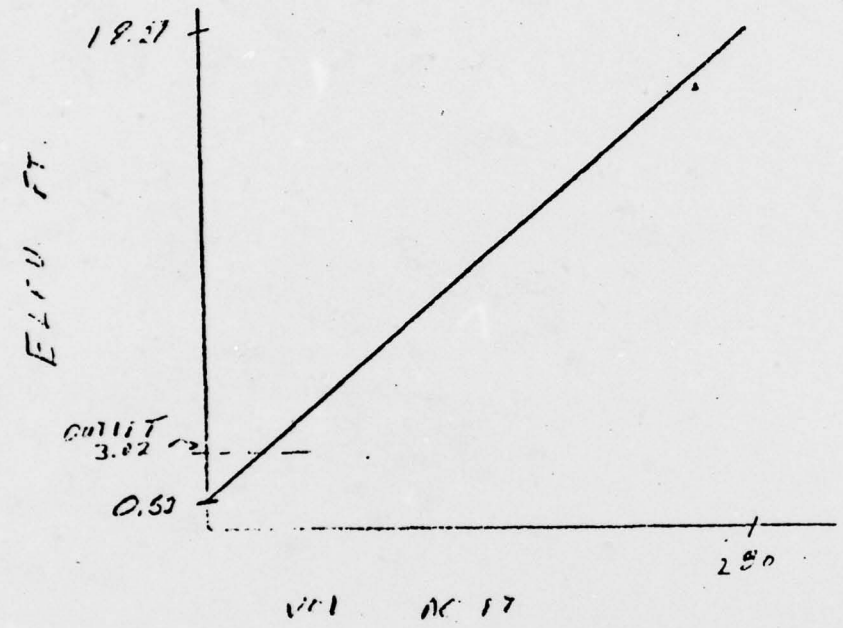
$$Q = 0.82A\sqrt{2gH} = 39.37\sqrt{H}$$

Water Surface El. behind the dam	H	$Q = 39.37\sqrt{H}$
18.27	15.25	154
19.27	16.25	159
21.27	17.25	164
2.27	0	0
6.27	3.25	71.0
10.27	7.25	106.0
14.27	11.25	132.0
18.27	15.25	154.0

Top of Dam

SPILLWAY CREST : ELEV = 18.21
⇒ ASSUME NWS VOL = 280 AC-FT

@ ELEV = 0.52' ⇒ VOL = 0.



SHEET NO. 14.

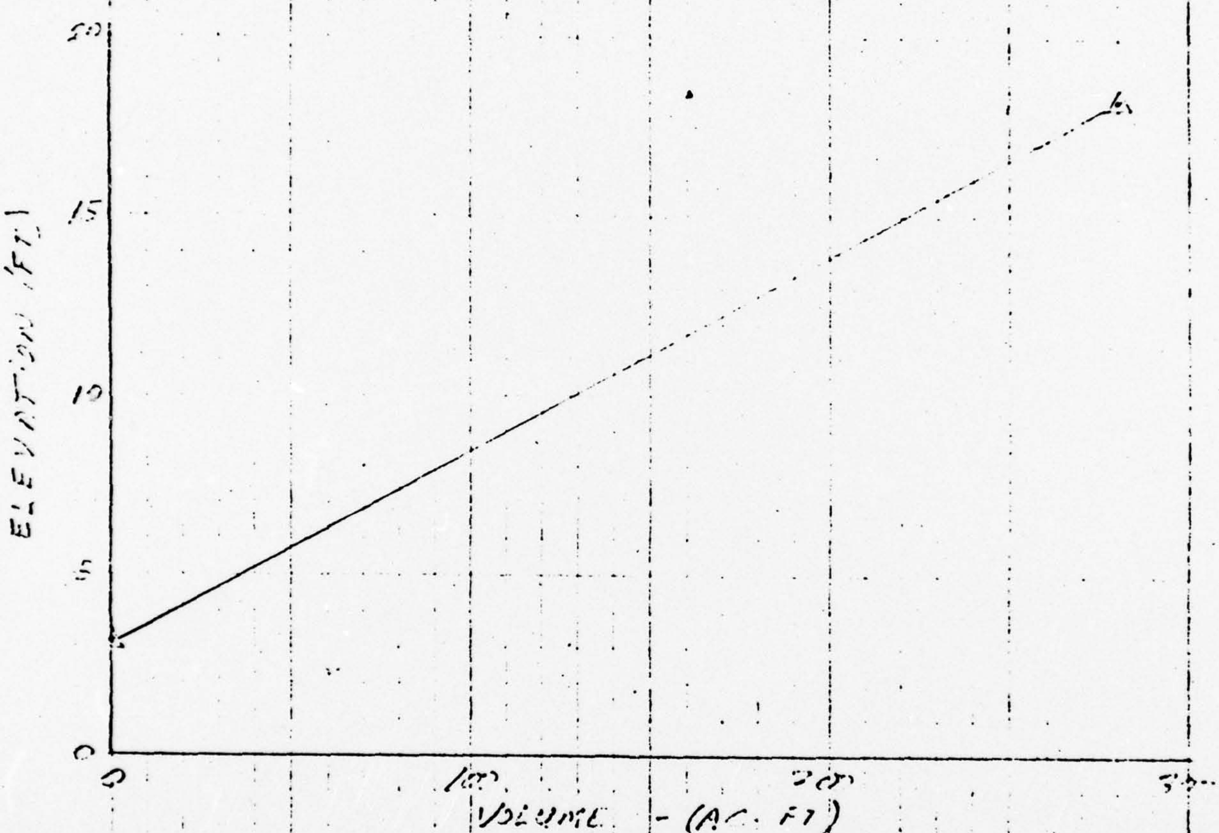
ASSUMED RESERVOIR CAPACITY CURVE — JOB NO. [illegible]

FOR INPUT TO [illegible] — BY [illegible] — DATE [illegible]

ASSUMED [illegible] 18.27 FT

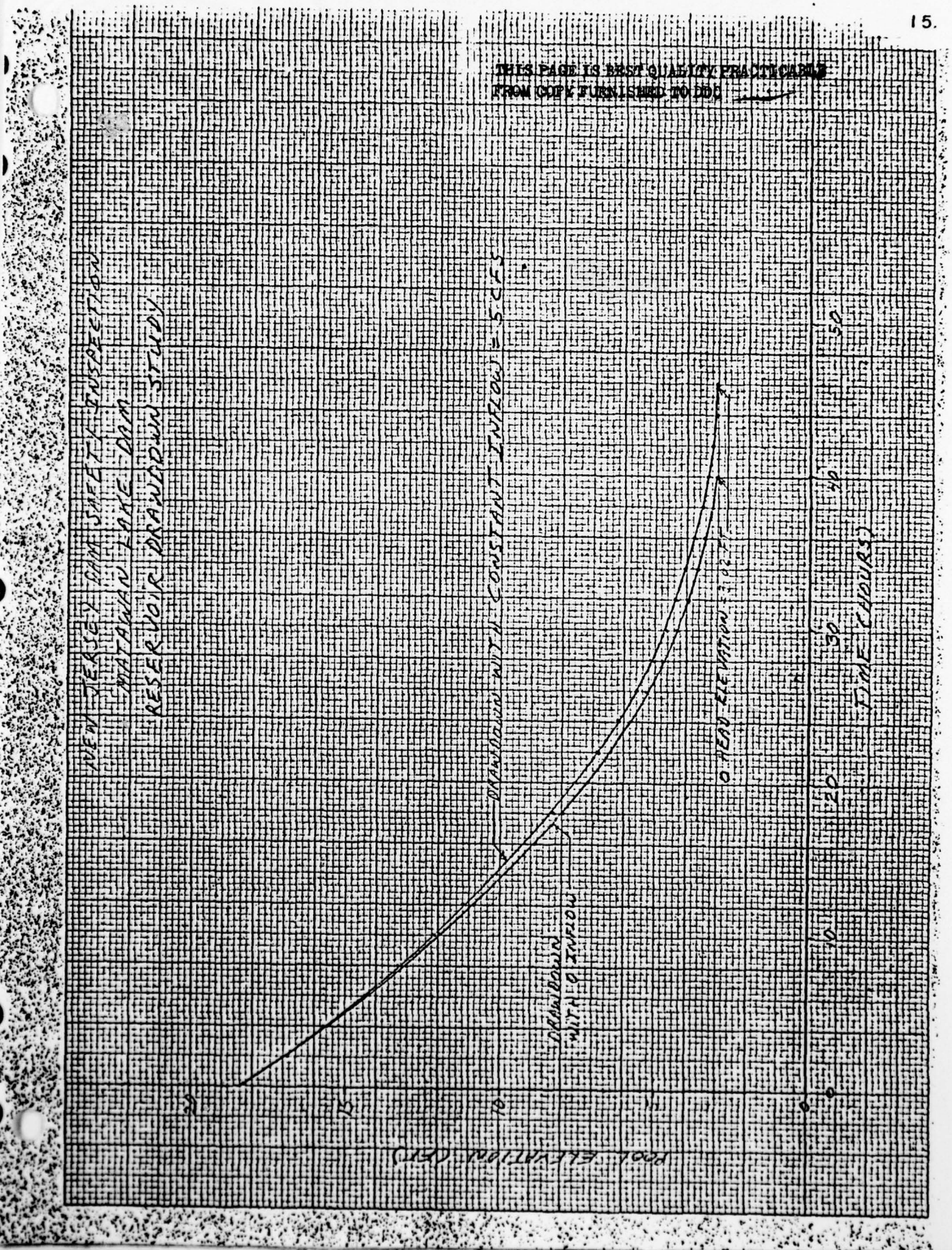
ASSUMED VOL @ [illegible] = 280 AC-FT

ASSUMED INVERT = 3.02 FT, 0 VOL.



INPUT VALUES FOR [illegible]

ELEV.	VOL.
3.02	0
6.07	56.
9.12	112.
12.17	168.
15.22	224.
18.27	280.



FLOOD ROUTING STUDY
****

MATANAN LAKE DAM RESERVOIR DRAWDOWN STUDY (DA = 2.7 SQ. MI.)

1.0000 UNREGULATED DIVERSION CONDUIT AT ELEV 3.02 FT

MAXIMUM OPERATION LEVEL AT ELEV 18.27 FT (FROM OPERATIO
MINIMUM OPERATION LEVEL AT ELEV 3.02 FT

ROUTING STARTS AT ELEV 18.27 FT, ENDS AT ELEV 3.02 FT

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
0	0		18.27			
		0.				
0	2		16.86	0.	0.	147.
		0.				
0	4		15.51	0.	0.	139.
		0.				
0	6		14.23	0.	0.	132.
		0.				
0	8		13.03	0.	0.	125.
		0.				
0	10		11.89	0.	0.	118.
		0.				
0	12		10.81	0.	0.	110.
		0.				
0	14		9.81	0.	0.	104.
		0.				
0	16		8.86	0.	0.	98.
		0.				
0	18		7.97	0.	0.	90.
		0.				
0	20		7.16	0.	0.	82.
		0.				
0	22		6.43	0.	0.	73.
		0.				
1	0		5.79	0.	0.	64.
		0.				
1	2		5.22	0.	0.	56.
		0.				
1	4		4.73	0.	0.	48.
		0.				
1	6		4.32	0.	0.	41.
		0.				
1	8		3.96	0.	0.	34.
		0.				
1	10		3.66	0.	0.	29.

FLOOD ROUTING STUDY
****

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
		0.				
1	12		3.41	0.	0.	24.
		0.				
1	14		3.20	0.	0.	21.
		0.				
1	16		3.02	0.	0.	17.

****

RESERVOIR ELEVATION WENT UNDER MINIMUM WATERSURFACE ELEVATION
AFTER 1 DAYS AND 16 HOURS

TOTAL INFLOW VOLUME	0.	ACFT
TOTAL DISCHARGE VOLUME	280.	ACFT
MAXIMUM WATER SURFACE ELEVATION	18.27	FT
MAXIMUM DISCHARGE THRU DIVERSION CONDUIT	147.	CFS
MAXIMUM TOTAL INFLOW	0.	CFS
MAXIMUM TOTAL DISCHARGE	154.	CFS

FLOOD ROUTING STUDY
****

MATAWAN LAKE DAM RESERVOIR DRAWDOWN STUDY (DA = 2.7 SQ. MI.)

1.0000 UNREGULATED DIVERSION CONDUIT AT ELEV 3.02 FT

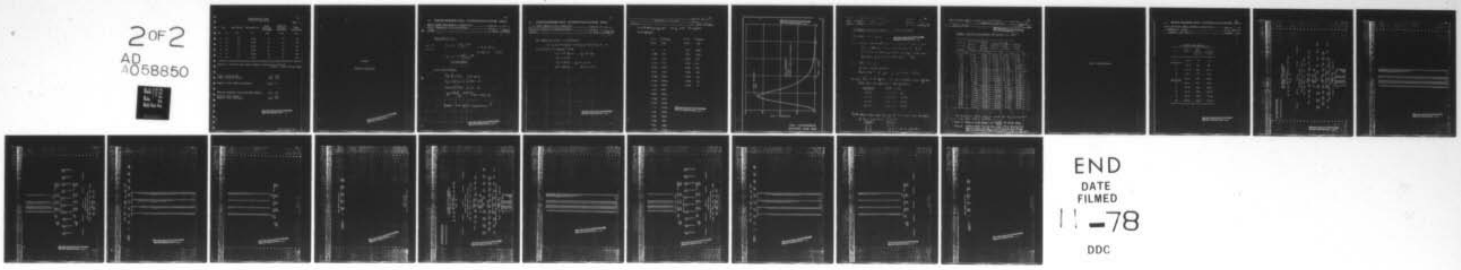
MAXIMUM OPERATION LEVEL AT ELEV 18.27 FT (FROM OPERATI
MINIMUM OPERATION LEVEL AT ELEV 3.02 FT

ROUTING STARTS AT ELEV 18.27 FT, ENDS AT ELEV 3.02 FT

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
0	0		18.27			
		5.				
0	2		16.90	0.	0.	147.
		5.				
0	4		15.61	0.	0.	140.
		5.				
0	6		14.38	0.	0.	133.
		5.				
0	8		13.21	0.	0.	126.
		5.				
0	10		12.11	0.	0.	119.
		5.				
0	12		11.07	0.	0.	112.
		5.				
0	14		10.10	0.	0.	105.
		5.				
0	16		9.18	0.	0.	100.
		5.				
0	18		8.32	0.	0.	93.
		5.				
0	20		7.53	0.	0.	86.
		5.				
0	22		6.81	0.	0.	78.
		5.				
1	0		6.17	0.	0.	70.
		5.				
1	2		5.60	0.	0.	62.
		5.				
1	4		5.11	0.	0.	54.
		5.				
1	6		4.68	0.	0.	47.
		5.				
1	8		4.32	0.	0.	41.
		5.				
1	10		4.01	0.	0.	35.

AD-A058 850 HARRIS ECI ASSOCIATES WOODBRIDGE NJ F/G 13/2
NATIONAL DAM SAFETY PROGRAM. MATAWAN LAKE DAM (NJ00086), RARITA--ETC(U)
JUL 78 R GERSHOWITZ DACW61-78-C-0100
UNCLASSIFIED NL

2 OF 2
AD
A058850



END
DATE
FILMED
11-78
DDC

FLOOD ROUTING STUDY
****

TIME		AVG.INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
1	12	5.	3.75	0.	0.	51.
1	14	5.	3.54	0.	0.	27.
1	16	5.	3.35	0.	0.	23.
1	18	5.	3.20	0.	0.	21.
1	20	5.	3.06	0.	0.	18.
1	22	5.	3.02	0.	0.	16.

****

RESERVOIR ELEVATION WENT UNDER MINIMUM WATERSURFACE ELEVATION
AFTER 1 DAYS AND 22 HOURS

TOTAL INFLOW VOLUME	21.	ACFT
TOTAL DISCHARGE VOLUME	303.	ACFT
MAXIMUM WATER SURFACE ELEVATION	18.27	FT
MAXIMUM DISCHARGE THRU DIVERSION CONDUIT	147.	CFS
MAXIMUM TOTAL INFLOW	5.	CFS
MAXIMUM TOTAL DISCHARGE	154.	CFS

APPENDIX

HYDROLOGIC COMPUTATION

ECI-4 ENGINEERING CONSULTANTS, INC.

NEW JERSEY DAM SAFETY INSPECTION
PME DERIVATION - MATAWAN DAM
UNG.

SHEET NO. ____ OF ____
JOB NO. ____
BY YIN DATE May 10

ESTIMATE OF T_c

$L_c = 1.7$
$L = 1.8$

$T_c = (11.9 L^3/H)^{.385}$

$L = 3.14$ miles,

$H = 290 - 15 = 275'$

$\therefore T_c = (11.9 (3.14)^3/275)^{.385}$

$= 1.12$ Hours.

UNIT HYDROGRAPH

(1,3,4)

$T_p = \frac{D}{2} + .6T_c$; $D = .25$ Hr

$T_p = .125 + .6 \times 1.12 = 0.797$ Hr.

$T_b = 2.67 \times T_p = 2.13$ Hr.

$q_p = 484 A/T_p = 484 \times 2.7/.797 = 1640$ cfs

Agrees with HOC-1 computation. ✓

ECI-4 ENGINEERING CONSULTANTS, INC.

NEW JERSEY DAM SAFETY - INSPECTION. SHEET NO. 1 OF _____

FLOOD ANALYSIS - NANTAHALA DAM. JOB NO. _____

UNIT HYD. BY YIN DATE May 11 '7

DERIVATION OF UNIT HYD. — 0.25 Hour.

Using SCS triangular hydrograph transformed to a curvilinear hydrograph with.

$A = 2.7$ Sq. mi ; $Q_p = 1610$ cfs

$T_c = 1.12$ Hr.

$T_p = 0.80$ Hr. , $T_b = 2.13$ Hr.

$D = .25$ Hr. $Q = 1.0$ inch

SHEET NO. 2 OF 22.

MIDDLE BIG RUN

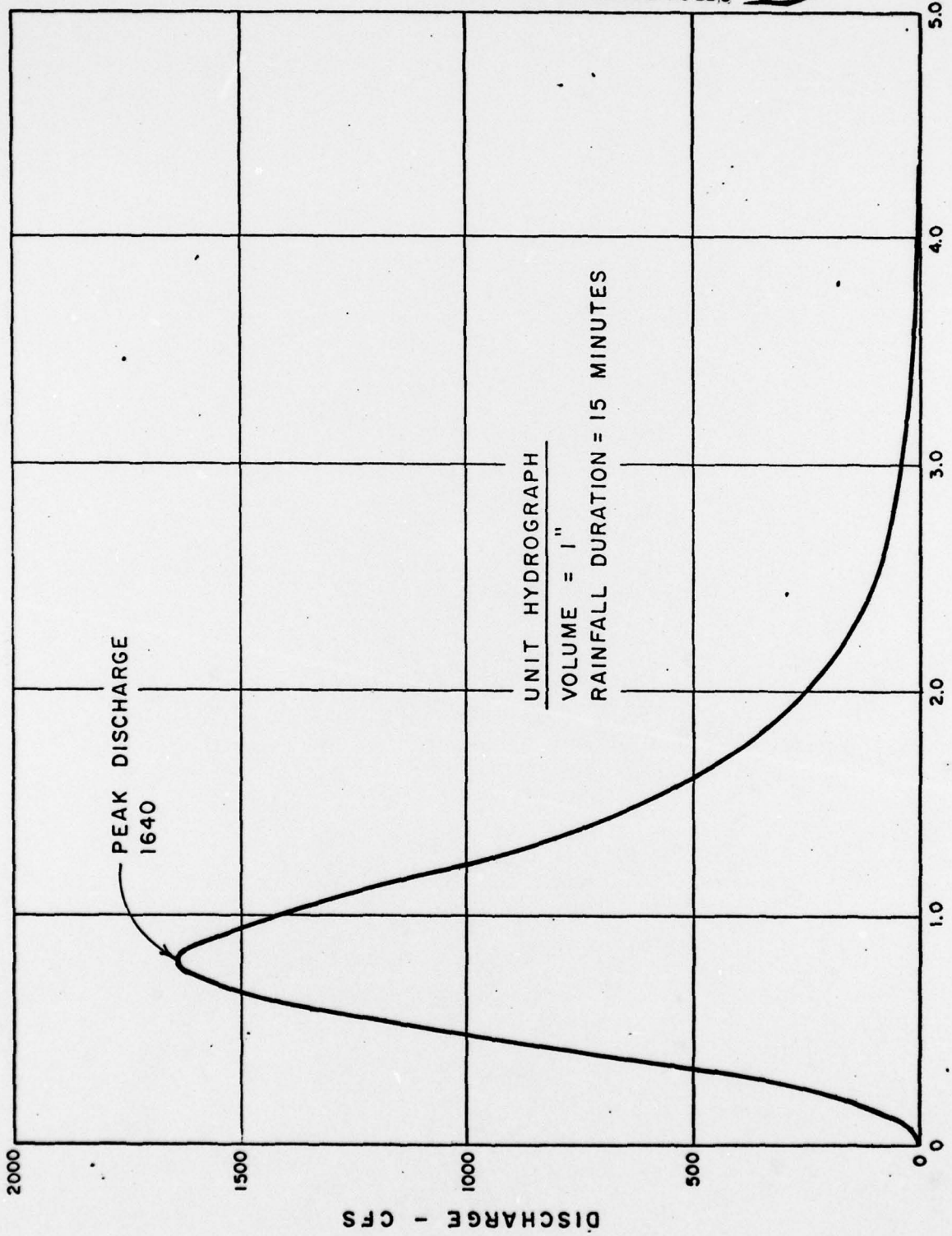
JOB NO.

BY YN DATE May 11

UHG.

Curvilinear hydrograph using SCS triangular hydrograph:

Time hours	Discharge cfs	Time hours	Discharge cfs
0	0	1.76	394
0.08	25	1.92	295
0.16	123	2.08	213
0.24	262	2.24	161
0.32	459	2.40	123
0.40	705	2.80	59
0.48	984	3.20	30
0.56	1263	3.60	15
0.64	1460	4.00	7
0.72	1591		
0.80	1640		
0.88	1607		
0.96	1509		
1.04	1378		
1.12	1230		
1.20	1082		
1.28	918		
1.44	689		
1.60	525		



UNIT HYDROGRAPH
MATAWAN LAKE DAM

[illegible] Flood Study
PMF Derivation - Mill [illegible]
Probable Maximum Precipitation

SHEET NO. 24. OF
JOB NO.
BY [illegible] DATE May 6 7[illegible]

PROBABLE MAXIMUM FLOOD (PMF)

DRAINAGE = 2.1 sq. mi

From Hydrometeorological Report #. "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Duration of 6, 12, 24 and 48 Hours" 1956

For D.A. = 10 sq mi
6 hour rainfall duration
PMP = 26" for Zone 6 at Mixon Basin.

Since D.A < 10 sq mi. No area reduction to be applied
PMP Values for various rainfall duration

Duration	PMP (inches)
6 Hr.	1 × 26 = 26"
12 Hr	1.09 × 26 = 28.34
24 Hr.	1.17 × 26 = 30.42
48 Hr.	1.26 × 26 = 32.76

PMP Values are reduced by 20% to account for misalignment of Basin and Storm [illegible]

Duration	PMP
6 Hr	20.8"
12 Hr	22.7"
24 Hr	24.3" Conservative.
48 Hr	26.2"

NEW TARBELA DAM SPILLWAY ALTERNATIVE — SHEET NO. ... OF ...

MIAWAN LAKE DAM — JOB NO. 1209-061

PMP – PMF — BY MAS YIN DATE 5/2.

DIRECT RUNOFF INCREMENTS FOR COMPUTING PMF

Time ending (hr)	Incremental design Rainfall (in)	Accumulative design Rainfall (in)	Direct Runoff: Accumulative	Direct Runoff: Incremental	Incremental loss
0.25	0.52	0.52	0.01	0.01	0.51
0.50	0.52	1.04	0.19	0.19	0.34
0.75	0.52	1.56	0.49	0.30	0.22
1.00	0.52	2.08	0.86	0.37	0.15
1.25	0.624	2.70	1.34	0.48	0.144
1.50	0.624	3.33	1.87	0.53	0.094
1.75	0.624	3.95	2.42	0.55	0.074
2.00	0.624	4.58	2.99	0.564	0.06 *
2.25	0.78	5.36	3.71	0.72	0.06
2.50	0.78	6.14	4.44	0.72	0.06
2.75	0.78	6.92	5.18	0.72	0.06
3.00	0.78	7.70	5.93	0.72	0.06
3.25	1.58	9.28	7.46	1.52	0.06
3.50	1.58	10.86	9.00	1.52	0.06
3.75	3.16	14.02	12.11	3.12	0.06
4.00	1.58	15.60	13.67	1.52	0.06
4.25	0.728	16.32	14.38	0.668	0.06
4.50	0.728	17.05	15.11	0.668	0.06
4.75	0.728	17.78	15.83	0.668	0.06
5.00	0.729	18.51	16.55	0.668	0.06
5.25	0.572	19.08	17.12	0.512	0.06
5.50	0.572	19.65	17.69	0.512	0.06
5.75	0.572	20.22	18.25	0.512	0.06
6.00	0.572	20.80	18.83	0.512	0.06

* Minimum loss rate is used for the succeeding hours from 2.24"/hr.

Column 4: Solution of run off equation $Q = \frac{(P-0.25)^2}{P+0.85}$ for CN = 85 AMC-II

Column 5: Difference between two consecutive values in Col. 4 up to the point when the minimum loss rate is reached indicated by the * mark. After that Col 5 values are obtained by subtracting min. loss rate from Col 2

HEC 1 - COMPUTATIONS

ECI-4 ENGINEERING CONSULTANTS, INC

NEW JERSEY DAM SAFETY INSPECTION — SHEET NO. 1 OF
MATAWAN DAM — JOB NO. 1207-001
INPUT TO HEC-1 — BY KLB DATE

INPUT TO HEC-1

*	ELEV (FT)	Y2 VOLUME (AC-FT)	Y3 DISCHARGE (CFS)
1 (SPILLWAY CREST)	17.0	0.	0.
2	18.0	31.	90.
3	19.0	62.	450.
4	19.5	77.	700.
5 (TOP OF DAM)	20.0	97.	1100.
6	20.5	119.	1500.
7	21.0	142.	2300.
8	21.5	164.	3200.
9	22.0	185.	4250.
10	23.0	228.	7300.

****
HEC-1 VERSION DATED JAN 1973
****

NEW JERSEY DAM SAFTEY - INSPECTION
500 YR FLOOD - MATAWAN LAKE DAM
UNIT HYDROGRAPH BY SCS METHOD

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
90	0	15	0	0	0	0	0	0	0

JOPER NWT
3 0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT UNIT HYDROGRAPH DERIVED BY SCS METHOD

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	-1	2.70	0.00	2.70	0.00	0.140	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
24	0.00	0.00	0.00

PRECIP PATTERN

0.00	0.18	0.30	0.37	0.48	0.53	0.55	0.56	0.72	0.72
0.72	0.72	1.52	1.52	3.12	1.52	0.67	0.67	0.67	0.67
0.51	0.51	0.51	0.51						

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

GIVEN UNIT GRAPH, NUHGQ= 18

0.	262.	1063.	1640.	1412.	967.	625.	388.	255.	163.
100.	70.	48.	25.	15.	10.	6.	1.		

UNIT GRAPH TOTALS 7048. CFS OR 1.01 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.00	0.00	0.
2	0.18	0.18	0.
3	0.30	0.30	47.
4	0.37	0.37	269.
5	0.48	0.48	711.
6	0.53	0.53	1265.
7	0.55	0.55	1853.

8	0.56	0.56	2419.
9	0.72	0.72	2893.
10	0.72	0.72	3291.
11	0.72	0.72	3710.
12	0.72	0.72	4136.
13	1.52	1.52	4467.
14	1.52	1.52	4900.
15	3.12	3.12	5894.
16	1.52	1.52	7714.
17	0.67	0.67	10184.
18	0.67	0.67	11695.
19	0.67	0.67	10948.
20	0.67	0.67	9167.
21	0.51	0.51	7633.
22	0.51	0.51	6525.
23	0.51	0.51	5694.
24	0.51	0.51	5012.
25	0.00	0.00	4508.
26	0.00	0.00	4053.
27	0.00	0.00	3601.
28	0.00	0.00	2514.
29	0.00	0.00	1498.
30	0.00	0.00	954.
31	0.00	0.00	602.
32	0.00	0.00	376.
33	0.00	0.00	232.
34	0.00	0.00	144.
35	0.00	0.00	90.
36	0.00	0.00	55.
37	0.00	0.00	28.
38	0.00	0.00	15.
39	0.00	0.00	8.
40	0.00	0.00	3.
41	0.00	0.00	0.
42	0.00	0.00	0.
43	0.00	0.00	0.
44	0.00	0.00	0.
45	0.00	0.00	0.
46	0.00	0.00	0.
47	0.00	0.00	0.
48	0.00	0.00	0.
49	0.00	0.00	0.
50	0.00	0.00	0.
51	0.00	0.00	0.
52	0.00	0.00	0.
53	0.00	0.00	0.
54	0.00	0.00	0.
55	0.00	0.00	0.
56	0.00	0.00	0.
57	0.00	0.00	0.
58	0.00	0.00	0.
59	0.00	0.00	0.
60	0.00	0.00	0.
61	0.00	0.00	0.
62	0.00	0.00	0.
63	0.00	0.00	0.
64	0.00	0.00	0.
65	0.00	0.00	0.
66	0.00	0.00	0.
67	0.00	0.00	0.
68	0.00	0.00	0.

69	0.00	0.
70	0.00	0.
71	0.00	0.
72	0.00	0.
73	0.00	0.
74	0.00	0.
75	0.00	0.
76	0.00	0.
77	0.00	0.
78	0.00	0.
79	0.00	0.
80	0.00	0.
81	0.00	0.
82	0.00	0.
83	0.00	0.
84	0.00	0.
85	0.00	0.
86	0.00	0.
87	0.00	0.
88	0.00	0.
89	0.00	0.
90	0.00	0.
SUM	18.25	128627.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11695.	5212.	1429.	1429.	128625.
INCHES		17.95	18.46	18.46	18.46
AC-FT		2585.	2658.	2658.	2658.

RUNOFF MULTIPLIED BY 0.14

0.	0.	6.	37.	99.	177.	259.	339.	405.	461.
520.	579.	626.	687.	826.	1081.	1427.	1639.	1535.	1285.
1070.	914.	798.	702.	632.	568.	462.	324.	210.	133.
84.	52.	32.	20.	12.	7.	3.	2.	1.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1639.	730.	200.	200.	18033.
INCHES		2.51	2.58	2.58	2.58
AC-FT		362.	372.	372.	372.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THRU MATAWAN LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	1	0	0	2	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	31.	62.	77.	97.	119.	142.	164.	185.	226.
OUTFLOW=	0.	90.	450.	700.	1100.	1500.	2300.	3200.	4250.	7400.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	0.	0.
2	0.	0.	0.
3	0.	3.	0.
4	0.	22.	1.
5	1.	68.	5.
6	4.	138.	13.
7	8.	218.	25.
8	14.	299.	41.
9	20.	372.	60.
10	28.	433.	82.
11	36.	490.	148.
12	43.	550.	234.
13	50.	603.	313.
14	56.	656.	387.
15	63.	756.	472.
16	71.	954.	613.
17	82.	1254.	819.
18	95.	1553.	1063.
19	104.	1587.	1232.
20	107.	1410.	1288.
21	105.	1177.	1253.
22	100.	992.	1170.
23	95.	856.	1069.
24	90.	750.	960.
25	84.	667.	859.
26	80.	600.	770.
27	76.	515.	685.
28	71.	393.	600.
29	65.	267.	502.
30	59.	171.	417.
31	53.	109.	351.
32	48.	66.	290.
33	43.	42.	237.
34	39.	26.	192.
35	36.	16.	154.
36	33.	10.	123.
37	31.	5.	98.
38	29.	3.	86.
39	28.	1.	81.
40	26.	0.	77.
41	25.	0.	72.
42	23.	0.	68.
43	22.	0.	64.
44	20.	0.	60.
45	19.	0.	57.
46	18.	0.	53.
47	17.	0.	50.
48	16.	0.	47.
49	15.	0.	44.
50	14.	0.	42.
51	13.	0.	39.
52	12.	0.	37.
53	12.	0.	35.
54	11.	0.	33.

55	10.	0.	31.
56	10.	0.	29.
57	9.	0.	27.
58	9.	0.	26.
59	8.	0.	24.
60	7.	0.	23.
61	7.	0.	21.
62	7.	0.	20.
63	6.	0.	19.
64	6.	0.	18.
65	5.	0.	17.
66	5.	0.	16.
67	5.	0.	15.
68	4.	0.	14.
69	4.	0.	13.
70	4.	0.	12.
71	4.	0.	12.
72	3.	0.	11.
73	3.	0.	10.
74	3.	0.	10.
75	3.	0.	9.
76	3.	0.	8.
77	2.	0.	8.
78	2.	0.	7.
79	2.	0.	7.
80	2.	0.	6.
81	2.	0.	6.
82	2.	0.	6.
83	2.	0.	5.
84	1.	0.	5.
85	1.	0.	5.
86	1.	0.	4.
87	1.	0.	4.
88	1.	0.	4.
89	1.	0.	4.
90	1.	0.	3.
SUM			17971.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1288.	664.	199.	199.	17971.
INCHES		2.28	2.57	2.57	2.57
AC-FT		329.	371.	371.	371.

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	1639.	730.	200.	200.	2.70
ROUTED TO	1	1288.	664.	199.	199.	2.70

1901 SOUTH NAVAJO, DENVER, COLORADO 80223

****
HEC-1 VERSION DATED JAN 1973

****

NEW JERSEY DAM SAFTEY - INSPECTION
100 YR FLOOD - MATAWAN LAKE DAM
UNIT HYDROGRAPH BY SCS METHOD

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
90	0	15	0	0	0	0	0	0	0

JOPER NWT
3 0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT UNIT HYDROGRAPH DERIVED BY SCS METHOD

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	-1	2.70	0.00	2.70	0.00	0.090	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
24	0.00	0.00	0.00

PRECIP PATTERN

0.00	0.18	0.30	0.37	0.46	0.53	0.55	0.56	0.72	0.72
0.72	0.72	1.52	1.52	3.12	1.52	0.67	0.67	0.67	0.67
0.51	0.51	0.51	0.51						

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

GIVEN UNIT GRAPH, NUMGG= 18

0.	262.	1063.	1640.	1412.	967.	625.	388.	255.	163.
100.	70.	48.	25.	13.	10.	6.	1.		

UNIT GRAPH TOTALS 7048. CFS OR 1.01 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.00	0.00	0.
2	0.18	0.18	0.
3	0.30	0.30	47.
4	0.37	0.37	269.
5	0.46	0.46	711.
6	0.53	0.53	1265.
7	0.55	0.55	1853.

8	0.56	0.56	2419.
9	0.72	0.72	2893.
10	0.72	0.72	3291.
11	0.72	0.72	3710.
12	0.72	0.72	4136.
13	1.52	1.52	4467.
14	1.52	1.52	4900.
15	3.12	3.12	5894.
16	1.52	1.52	7714.
17	0.67	0.67	10184.
18	0.67	0.67	11695.
19	0.67	0.67	10948.
20	0.67	0.67	9167.
21	0.51	0.51	7633.
22	0.51	0.51	6525.
23	0.51	0.51	5694.
24	0.51	0.51	5012.
25	0.00	0.00	4508.
26	0.00	0.00	4053.
27	0.00	0.00	3301.
28	0.00	0.00	2314.
29	0.00	0.00	1498.
30	0.00	0.00	954.
31	0.00	0.00	602.
32	0.00	0.00	376.
33	0.00	0.00	232.
34	0.00	0.00	144.
35	0.00	0.00	90.
36	0.00	0.00	53.
37	0.00	0.00	28.
38	0.00	0.00	15.
39	0.00	0.00	8.
40	0.00	0.00	3.
41	0.00	0.00	0.
42	0.00	0.00	0.
43	0.00	0.00	0.
44	0.00	0.00	0.
45	0.00	0.00	0.
46	0.00	0.00	0.
47	0.00	0.00	0.
48	0.00	0.00	0.
49	0.00	0.00	0.
50	0.00	0.00	0.
51	0.00	0.00	0.
52	0.00	0.00	0.
53	0.00	0.00	0.
54	0.00	0.00	0.
55	0.00	0.00	0.
56	0.00	0.00	0.
57	0.00	0.00	0.
58	0.00	0.00	0.
59	0.00	0.00	0.
60	0.00	0.00	0.
61	0.00	0.00	0.
62	0.00	0.00	0.
63	0.00	0.00	0.
64	0.00	0.00	0.
65	0.00	0.00	0.
66	0.00	0.00	0.
67	0.00	0.00	0.
68	0.00	0.00	0.

69	0.00	0.00	0.
70	0.00	0.00	0.
71	0.00	0.00	0.
72	0.00	0.00	0.
73	0.00	0.00	0.
74	0.00	0.00	0.
75	0.00	0.00	0.
76	0.00	0.00	0.
77	0.00	0.00	0.
78	0.00	0.00	0.
79	0.00	0.00	0.
80	0.00	0.00	0.
81	0.00	0.00	0.
82	0.00	0.00	0.
83	0.00	0.00	0.
84	0.00	0.00	0.
85	0.00	0.00	0.
86	0.00	0.00	0.
87	0.00	0.00	0.
88	0.00	0.00	0.
89	0.00	0.00	0.
90	0.00	0.00	0.
SUM	18.25	18.25	128627.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11695.	5212.	1429.	1429.	128625.
INCHES		17.95	18.46	18.46	18.46
AC-FT		2585.	2658.	2658.	2658.

RUNOFF MULTIPLIED BY 0.09

0.	0.	4.	24.	64.	114.	167.	219.	262.	298.
336.	374.	404.	444.	534.	698.	922.	1059.	991.	830.
691.	591.	515.	454.	408.	367.	299.	209.	135.	86.
54.	34.	21.	13.	8.	4.	2.	1.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1059.	472.	129.	129.	11653.
INCHES		1.62	1.67	1.67	1.67
AC-FT		234.	240.	240.	240.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THRU MATAWAN LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	31.	62.	77.	97.	119.	142.	164.	183.	228.
OUTFLOW=	0.	90.	450.	700.	1100.	1500.	2300.	3200.	4250.	7600.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	0.	0.
2	0.	0.	0.
3	0.	2.	0.
4	0.	14.	0.
5	1.	44.	3.
6	2.	89.	8.
7	5.	141.	16.
8	9.	193.	26.
9	13.	240.	39.
10	18.	280.	53.
11	23.	317.	68.
12	29.	355.	85.
13	35.	389.	137.
14	40.	424.	198.
15	45.	489.	261.
16	52.	616.	337.
17	61.	810.	438.
18	70.	991.	596.
19	78.	1025.	726.
20	81.	911.	789.
21	81.	761.	780.
22	78.	641.	732.
23	75.	553.	675.
24	72.	485.	619.
25	68.	431.	564.
26	65.	387.	512.
27	62.	353.	459.
28	58.	254.	413.
29	54.	172.	361.
30	49.	111.	307.
31	45.	70.	257.
32	41.	44.	211.
33	38.	27.	172.
34	35.	17.	138.
35	32.	10.	111.
36	30.	6.	89.
37	29.	3.	84.
38	27.	1.	79.
39	25.	1.	75.
40	24.	0.	70.
41	23.	0.	66.
42	21.	0.	62.
43	20.	0.	59.
44	19.	0.	55.
45	18.	0.	52.
46	17.	0.	49.
47	16.	0.	46.
48	15.	0.	43.
49	14.	0.	41.
50	13.	0.	38.
51	12.	0.	36.
52	11.	0.	34.
53	11.	0.	32.
54	10.	0.	30.

55	9.	0.	28.	
56	9.	0.	27.	
57	8.	0.	25.	
58	8.	0.	24.	
59	7.	0.	22.	
60	7.	0.	21.	
61	6.	0.	20.	
62	6.	0.	18.	
63	6.	0.	17.	
64	5.	0.	16.	
65	5.	0.	15.	
66	5.	0.	14.	
67	4.	0.	14.	
68	4.	0.	13.	
69	4.	0.	12.	
70	4.	0.	11.	
71	3.	0.	11.	
72	3.	0.	10.	
73	3.	0.	9.	
74	3.	0.	9.	
75	2.	0.	8.	
76	2.	0.	8.	
77	2.	0.	7.	
78	2.	0.	7.	
79	2.	0.	6.	
80	2.	0.	6.	
81	2.	0.	6.	
82	1.	0.	5.	
83	1.	0.	5.	
84	1.	0.	5.	
85	1.	0.	4.	
86	1.	0.	4.	
87	1.	0.	4.	
88	1.	0.	3.	
89	1.	0.	3.	
90	1.	0.	3.	
SUM			11596.	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	789.	412.	128.	128.	11596.
INCHES		1.42	1.66	1.66	1.66
AC-FT		204.	239.	239.	239.

********** ********** ********** ********** **********

RUNOFF SUMMARY: AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	1059.	472.	129.	129.	2.70
ROUTED TO	1	789.	412.	128.	128.	2.70